UNITED STATES DEPARTMENT OF AGRICULTURE

REPORT ON THE AGRICULTURAL EXPERIMENT STATIONS, 1930

PREPARED BY THE
OFFICE OF EXPERIMENT STATIONS

For sale by the Superintendent of Documents, Washington, D. C. - - - - Price 15 cents

OFFICE OF EXPERIMENT STATIONS

W. H. Evans, Acting Chief

RELATIONS WITH THE STATE EXPERIMENT STATIONS

W. H. Evans, W. H. Beal, G. Haines, J. I. Schulte, Sybil L. Smith, R. W. Trullinger, B. Youngblood

EXPERIMENT STATION RECORD

Editor: Howard Lawton Knight

Agricultural and Biological Chemistry—H. C. Waterman and Sybil L. Smith.
Meteorology—W. H. Beal.
Soils and Fertilizers—H. C. Waterman.
Agricultural Botany, Diseases of Plants—W. H. Evans and W. E. Boyd.
Genetics—H. M. Steece, J. W. Wellington, and G. Haines.
Field Crops—H. M. Steece.
Horticulture, Forestry—J. W. Wellington.
Economic Zoology and Entomology, Veterinary Medicine—W. A. Hooker.
Animal Husbandry, Dairying, and Dairy Farming—H. W. Marston.
Agricultural Engineering—R. W. Trullinger.
Agricultural Economics and Rural Sociology, Agricultural and Home Economics Education—F. G. Harden.
Foods and Human Nutrition—Sybil L. Smith.
Textiles and Clothing—H. M. Steece and Sybil L. Smith.
Home Management and Equipment— ——— ———.
Indexing—Martha C. Gundlach.
Bibliographies—Cora L. Feldkamp.

DIVISION OF INSULAR STATIONS

W. H. Evans, Chief

Alaska Stations, Sitka: H. W. Alberts, Director.
Guam Station, Guam: C. W. Edwards, Director.
Hawaii Station, Honolulu: J. M. Westgate, Director.
Porto Rico Station, Mayaguez: T. B. McClelland, Director.
Virgin Islands Station, Christiansted, St. Croix: J. R. Ricks, Director.

UNITED STATES DEPARTMENT OF AGRICULTURE

OFFICE OF EXPERIMENT STATIONS

Washington, D. C. July, 1931

REPORT ON THE AGRICULTURAL EXPERIMENT STATIONS, 1930

By W. H. Beal and H. M. Steece[1]

CONTENTS

INTRODUCTION

This report, like those of previous years, gives an annual review of the work and expenditures of the agricultural experiment stations in the several States and in Alaska, Hawaii, Porto Rico, Guam, and the Virgin Islands, with some discussion of questions of organization and policy. It notes progress in all lines of station work, but particularly in investigation in agricultural economics and rural sociology, home economics, and agricultural engineering during the five years since the passage of the Purnell Act.

THE FIRST FIVE YEARS OF THE PURNELL ACT

The Purnell Act reached its maximum of $60,000 annually for each State during the year. This act authorized an initial appropriation of $20,000 for each State for the fiscal year 1926, with annual increments of $10,000 until a total of $60,000 had been reached, which amount was then to become the fixed annual appropriation under the act.

In reviewing the accomplishments under this act from its passage up to the time when the obligation of the Government to supply annually increasing sums was reached, it may be said in general that the stations have made good use of the funds provided by the act in enlarging their fields of activity, increasing and improving their personnel, and securing more prompt and adequate publication of the results of their research. More particularly has this been true of their work in the less developed fields of research for which adequate financial support had not previously been available, namely, agricultural economics, rural sociology, home economics, and agricultural engineering.

[1] With the collaboration of other members of the office staff.

57146—31——1

ECONOMICS AND SOCIOLOGY

At the time of its enactment in 1925, the Purnell Act was widely accepted as a most important piece of agricultural legislation. It was interpreted as a broad recognition of the fact that the farmers' problems, whether physical, biological, or social, could best be solved by methods of scientific research. Evidence of progress, therefore, in economic and sociological research at the stations since the passage of the Purnell Act should be of interest not only to research specialists and educational leaders but also to farmers and the public as well. Although no method has yet been devised whereby social progress can be measured with precision, it becomes rather evident that, when judged by the standards ordinarily applied to the accomplishments of the older sciences, noteworthy advance has been made during the last five years in rural economic and sociological research. Comparing the present with five years ago, progress will be noted in the number, training, and experience of the personnel; in the number and character of projects undertaken; in cooperative relations existing among specialists within particular station organizations, among stations in the same agricultural region, and between State stations and Federal bureaus; in the correlation of rural social with natural science research projects; in the degree of completeness of the research programs developed; and in the significance of published results.

In 1924–25, the stations reported 200 projects in rural economics and 34 in rural sociology; whereas, in 1929–30, the stations reported 463 projects in rural economics and 46 in sociology. Between 1925 and 1930, 202 agricultural economic and 33 sociological projects were completed, discontinued, or revised. From the viewpoint of diversity of effort, it is interesting to note that of the number of projects under way in 1924–25 there were 35 projects in farm management, whereas in 1929–30 there were 152. In 1924–25 there were 59 cost-of-production projects and only 49 in 1929–30, indicating, perhaps, a lessening of interest in cost-of-production projects, as such, and their absorption by other farm-management projects.

A further comparison between 1924–25 and 1929–30 discloses the fact that, at most of the stations, more adequate programs of economics research are being evolved. Prior to the World War much of the work was fragmentary, scattered, and unrelated, and the major effort was confined largely to the study of farm-management problems, or the economics of primary production on the farms. Most of the projects undertaken dealt with such subjects as farm costs, practices, enterprises, and organizations. Collectively, the effort was primarily to adapt the type of farming not so much to changing economic conditions as to local environmental factors of soil, surface, and climate. Marketing studies were still in their formative stage. Such studies as were under way related chiefly to farmers' local or regional markets. Not enough dependable information was available concerning the national and world markets and their prospective demands. In 1924–25, the number of active marketing projects at the stations was 43, whereas, in 1929–30, there were 139. During this time, the number of projects upon agricultural prices had increased from 9 to 20; upon land economics, from 18 to 31; upon farm taxation, from 5 to 18; and the number of miscellaneous economic projects, from 31 to 52. As the figures suggest, there has been a noteworthy increase in the number of projects dealing with problems encountered on the demand side of the farmer's markets and with the broad problems of agricultural finance, taxation, and land utilization.

Though research in rural sociology has made less headway in the aggregate than that in agricultural economics, the progress during the last five years has been in many respects satisfactory. In 1924–25, there were 34 active projects in this field of study. By 1929–30, there were 46 projects, including 11 upon costs and standards of living; 7 upon population problems; 18 upon social groups, institutions, and organizations; 3 in social psychology; and 7 miscellaneous projects.

In both agricultural economics and rural sociology, progress is apparent in matters of more clearly defined problems, stating objectives and methods of procedure, and interpretation of data. Advance has also been made in the number, preparation, and accomplishments of the specialists in both fields of effort. A comparison of degrees held by the specialists shows more master's and doctor's and fewer bacholor's degrees at the present time than were held in 1924–25. In 1924–25 there were 112 research specialists in agricultural economics and only 7 in rural sociology; whereas, in 1929–30, there were 250 specialists in agricultural economics, and 26 in rural sociology.

Progress at the experiment stations has been accompanied by noteworthy developments in the United States Department of Agriculture. The Bureau of Agricultural Economics constructively emphasized research as a

basis for regulatory, extension, and service activities. The emphasis originally placed upon the economic aspects of primary production has been broadened to embrace thoroughgoing studies of competition and prices, cooperation and land utilization, finance and taxation, income and rural life. Only recently, a foreign agricultural service was organized for the purpose of making comprehensive studies of foreign demand and competition as means to a better understanding of domestic markets, prices, and other matters essential to national agricultural adjustment. The greater proportion of the projects of the bureau are carried on in cooperation with the State agricultural experiment stations.

The crucial test of rural economics and sociological research is the significance of results, and their practicability in matters of readjustment. During the five years which have elapsed since the enactment of the Purnell Act, the Office of Experiment Stations has received a total of 205 station publications presenting results of farm-management, cost-of-production, and other studies which collectively may be designated as economics of production, 161 publications dealing with marketing and prices, 54 dealing with land economics, taxation, and credits, 26 miscellaneous, and 52 presenting results of rural sociological studies. From the publications it is noted that, although the older studies pertaining to the economics of production were stimulated by the support received from the Purnell fund, the greatest expansion of effort has been in the field of marketing, prices, and specialized studies such as land economics, taxation, and agricultural finance. The general tendency has been to fill in the gaps and round out the programs of economic and sociological research so that the body of information thus created may be more complete.

Though much remains to be accomplished in matters of selecting problems for study, refining research methods, interpreting results, and perfecting the style of presentation in publications, it must be admitted that, everything considered, both agricultural economic and rural sociological research in the United States have really made remarkable advancement in the relatively short period of their existence. With the productive powers of farmers becoming more and more effective, and with American agriculture tending more and more towards commercial objectives, greater emphasis is being placed upon the importance of better incomes for the farmer and his family and better standards and higher planes of rural living. Instead of depending upon empirical methods such as have characterized the greater part of our national experience, research in agricultural economics and rural sociology will hereafter be looked to for the information needed in efforts to assure rural advancement.

B. YOUNGBLOOD.

HOME ECONOMICS

In a previous report[2] it was noted that before the Purnell Act went into effect, research receiving Federal financial support was being conducted in the home economics departments of land-grant institutions in only 4 States, while during the first year in which Purnell funds were available this number increased to 36, a remarkable expansion in that brief time. In 1930, 44 States and Hawaii carried on home economics research. In at least 3 of the 4 States in which home economics research received no Federal support projects having a direct bearing upon foods and human nutrition were being conducted in other departments.

Organization and administration.—One of the most serious problems confronting some of the experiment station directors in providing for home economics research in their program was the organization of a research department. In the States in which the home economics division of the land-grant college or university is on the same campus as the experiment station, three possibilities were open: (1) To delegate the responsibility of developing a research program to the head of the home economics division of resident teaching; (2) to set up a more or less independent research unit within the home economics division, making use of laboratory and office space and equipment, but with the research leaders responsible only to the experiment station directors; and (3) to organize the home economics research as a regular division of the experiment station with no direct connection with the division of resident teaching.

In the States in which the experiment stations are located elsewhere than at the State colleges or universities at which home economics is taught, the choice lay between establishing a new department or division of home economics research within the experiment station or allocating funds for research

[2] SMITH, S. L. DEVELOPMENT OF HOME ECONOMICS RESEARCH AT THE AGRICULTURAL EXPERIMENT STATIONS UNDER THE PURNELL ACT. U. S. Dept. Agr., Off. Expt. Stas., Rpt. Agr. Expt. Stas. 1926: 89–96. 1927.

to the resident teaching departments located elsewhere. All these different administrative arrangements are represented in the present program of home economics research. To discuss the advantages and disadvantages of the various systems is beyond the scope of this report, but attention has been called to them to illustrate the difficulty in attempting to make comparisons between States as to the financial support of home economics research, the scope of the research program, and the progress which has been made in the last five years.

Personnel.—The sudden expansion in research made possible by the Purnell Act created an unprecedented demand for research workers in home economics. In some of the States in which the research was organized within the home economics divisions of the land-grant institutions, many of the teaching staff took on the extra burden of carrying on one or two research projects, sometimes with very little relief from their teaching schedule and no assistance beyond that of graduate students. Progress in research under such conditions has of necessity been slow, and in a few instances the quality as well as the quantity of work has been inferior on account of inexperience or inaptitude for research. In other cases the plan has worked out satisfactorily through the lightening, by some increase in the teaching staff, of the teaching schedule of those also engaged in research. So great was the demand for full-time research in the States in which new research departments for home economics were organized that it became difficult to secure sufficiently trained workers in certain fields. This situation was in no small degree responsible for the large proportion of projects in foods and nutrition, a field in which it was comparatively easy to find well-trained workers. On the other hand, the incentive to taking up research as a profession, which the unusual demand for research workers created, has already had its effect in the strengthening of the curricula in home economics divisions with preparation for graduate study in mind, and in the increasing number of home economics graduates returning to universities for graduate study in the newer fields of economics.

Of the 103 project leaders and assistants listed in a compilation of home economics research projects receiving Purnell support for 1930–31, 33 have the degree of doctor of philosophy, 59 the master's degree, and 11 the bachelor's degree. That almost 90 per cent have had some graduate work and 32 per cent have had the experience in original research required for the degree of doctor of philosophy indicates standards comparing very favorably with those of the longer established experiment station divisions.

Financial support.—The available figures regarding allotment of funds to different lines of station work indicate that over 10 per cent of the total amount provided by the Purnell Act has been used for home economics research. In the research programs of the stations for 1930–31 the lowest allotment of Purnell funds for home economics research is $1,250 and the highest $15,330, a wide range. In 2 States over one-fourth, in 2 others over one-fifth, and in 4 others over one-sixth of the entire Purnell fund goes to home economics. Up to the present time there has been little financial support for home economics research except from Purnell funds, and these have now reached their maximum, but no doubt home economics leaders on the basis of their past experience will be able to present research programs which will merit additional support from other sources.

Classification of projects.—Home economics is a changing field. In the early days it consisted chiefly of cooking and sewing, which gradually expanded into foods and nutrition and textiles and clothing. In recent years the management of the home has been recognized as something more than feeding and clothing the family, until finally there have been added to the subject matter divisions of long standing family relationships, comprising the physical, social, and economic aspects of family life; family economics, dealing with income, productive activities, purchasing problems, management of finances, and standards and cost of living; and the house, comprising housing economics, house planning, construction, equipment and furnishing, and housekeeping standards and management. An ideal program of research in home economics should include projects in all these fields. Considering the Purnell program of home economics research as a whole, all the fields are represented, though in disproportionate degree, with the exception of family relationships, a field of research which has not come into the experiment station program to any extent except perhaps in some of the rural sociology projects.

Including in home economics research projects a few conducted in other departments but obviously of primary value to home economics, the list as of November 1, 1930, totaled 156 projects. With due allowance for the difficulty of

classifying correctly certain projects of rather wide or indefinite scope, these projects may be grouped roughly as follows: Foods and nutrition, 100; textiles and clothing, 7; family economics, 28; and the house, 21.

The disproportionate number of projects in foods and nutrition may not represent a correspondingly large proportion of time or funds, since research in foods lends itself to definite, small, clear-cut projects as compared with some of the broad and general topics under family economics and the long-time projects in equipment. Another factor which should not be overlooked in attempting to explain what seems to be an overbalance of projects in foods and nutrition is that home economics has been called upon from the first to do service work in this field for other departments. This has been particularly true of the cooperation of the home economics departments in studies of factors affecting the quality and palatability of meat, of major interest to the animal husbandman, and in some of the vitamin studies, of primary interest to the agronomist or horticulturist, as well as to the animal husbandman.

The small number of projects in textiles and clothing is attributable chiefly to the difficulty of finding trained workers in this field and the great expense of establishing properly equipped laboratories.

Considering the broad scope of even the best-defined projects in the field of family economics and the comparatively few well-trained researchers in this field, the number and type of projects compare favorably with the other fields of research. With each succeeding year the necessity is increasingly felt for highly specialized training for this type of research, and fewer are undertaking projects in this field without this special training. The advisability of active cooperation with the departments of agricultural economics and rural sociology is also being felt more keenly than in the beginnings of research in this field.

For successful research in the various topics included in the "house" group, it has been recognized from the first that cooperation with departments of engineering and of physics is essential. Not only are a number of equipment projects joint projects of the home economics and agricultural engineering departments, but in one or two stations the engineering departments have become sufficiently interested in home engineering problems to undertake research along these lines independently.

Notable advance has been made in interdepartmental cooperation in various lines of home economics research, but perhaps one of the most important effects of the establishment on a substantial scale of home economics research at the experiment stations has been the interest awakened in coordinating family economics with farm economics and home engineering with agricultural engineering.

Publications.—The yearly lists of station publications show that over 50 station bulletins and circulars reporting results of home economics research have been issued since the passage of the Purnell Act. In addition to these official publications and the customary progress reports of the station directors, a creditable number of papers have appeared in various journals, including especially the Journal of Agricultural Research, the Journal of Biological Chemistry, and the Journal of Nutrition. Some of the briefer reports, particularly in foods and nutrition, have appeared in the Journal of Home Economics. Judged by the published output, the experiment stations are making a substantial contribution in the field of home economics research.

SYBIL L. SMITH.

AGRICULTURAL ENGINEERING

Previous to the passage of the Purnell Act, agricultural engineering research had made very slow and uncertain growth. The period from 1925 to 1930, however, was one of development, enlargement, and improvement, much of which may be attributed either directly or indirectly to the influence of the act.

Evidence of the influence of the Purnell Act is found in the fact that 317 projects in agricultural engineering were in progress at 40 experiment stations at the end of the last fiscal year, as compared with 189 projects active on June 30, 1925—an increase of practically 70 per cent in projects during the first five years of the act, whereas during the previous 5-year period the increase was from 159 to 189, or barely 20 per cent. Purnell projects in agricultural engineering increased from 25 in 1925–26, the first year of the act, to 59 in 1929–30.

There has been substantial increase in funds devoted to agricultural engineering investigations since the passage of the Purnell Act and also in the published output of results. The number of station publications reporting results of investigations in this field increased from 107 for the five years preceding

the passage of the act to 183 for the 5-year period following its passage. There was also a large increase in articles based on such investigations published in the Journal of the American Society of Agricultural Engineers and other engineering and agricultural journals.

The most important and profound influence of the act on agricultural engineering research appears, however, to have been the stimulation of investigations of more fundamental character, having as their primary purpose the establishment of a scientific basis for more economical and efficient practical methods and equipment. Formerly, studies of requirements of seed-bed preparation and tillage for different crops were confined largely to efforts to adapt available tillage implements as economically as possible to different conditions. During the last five years, however, the experiment stations have recognized the fundamental inadequacies of many of these implements and have striven to determine the principles of soil dynamics which govern the design of more efficient tillage tools. Also by cooperation between agronomists and engineers some progress has been made toward the definite measurement of the degrees of tilth required in soil by different crops. Thus a foundation of the basic principles of economical tillage methods and efficient tillage machinery is being laid which already has made it possible to secure the tilth conditions required by crops in certain soils at reduced cost for power and labor.

The high cost of power for agricultural draft operations has been attacked especially in studies of the efficiency of draft machinery. The tractor, previously tested as a unit, has been subjected to rigid analysis and has been improved in many of its component parts, thus contributing materially to its aggregate efficiency as a draft machine. This has been reflected in the improved tractive efficiency and stability of the tractor and in the greater durability, flexibility, economy, and output of the tractor motor under the severe stress of agricultural service. Outstanding progress has been made in the development of the small unit general-purpose tractor and its more economical adaptation to smaller-sized farming units.

Harvesting methods and machinery for grain, hay, and root crops have undergone considerable development during the last five years, largely as a result of work done with Purnell funds. Studies in regard to the development and improvement of various defective features of the combine for its better adaptation to the harvesting and threshing of small grains, soybeans, grain sorghums, and even corn, have resulted in increased efficiency and in measurable economy in the necessary expenditure of power, labor, and time. Similar progress also has been made in the mechanization of the harvesting operation for potatoes and other root crops.

Progress has been made in the development of more efficient methods for the harvesting and artificial curing of hay. Begun with tests of commercial hay driers, this investigation has been extended to include studies of the mechanism of the process of hay ripening and removal of moisture therefrom and how these may be controlled. In some cases the investigations have advanced to the point where basic mechanical principles of artificial curing processes are being translated gradually into terms of efficient and economical equipment. Similiar progress has been made in the artificial curing of soft corn, and of wheat, rice, and other small grains harvested by the combine.

In the arid and semiarid sections and in some humid sections definite progress has been recorded in placing the different land-reclamation practices, including irrigation and drainage, on a sounder basis. Laboratory studies of the fundamental factors of soil hydraulics and of plant physiology which govern the economical use of irrigation water have largely replaced the duty of water field tests and have yielded much basic information relating to the proper time and most economical quantity of irrigation water required for different crops on certain soil types. This is making possible greater precision in the design of irrigation equipment, better control of irrigation operations, and more effective and economical use of the water by crops.

The knowledge of the availability of electricity as an efficient, economical, and exceedingly flexible source of energy for use in agricultural operations and practices has been increased considerably under both the direct and indirect influence of investigations made possible by the Purnell Act. During the last five years the profitable adaptation of this source of energy has been extended, not only to the ordinary belt-power uses, but to dairy refrigeration, milk precooling, ultra-violet ray sterilization of milk, utensil sterilization, cooking, greenhouse and hotbed stimulation, and poultry incubation and brooding, and efforts are even being made to extend its use to field opera-

tions. Inquiry in the subject has been so stimulated that an exhaustive national survey of research problems in agricultural electrification is now under way for the purpose of organizing a more practical and better unified research program.

Funds provided by the act have been a factor in the development of sound research in soil erosion and storm run-off prevention. Controlled studies of the factors of efficiency in terracing practices based upon fundamental conceptions of soil technology and dynamics and engineering hydraulics have largely replaced simple terracing demonstration tests and are revealing some of the fundamental reasons for the destructive action of storm water on certain soils and indicating how it may be controlled effectively and the moisture conserved.

In brief, the Purnell Act has been influential in enlarging and improving the work of the stations in agricultural engineering, giving it a better status in the station research program and increasing the output of information useful in agricultural practice.

ROBERT W. TRULLINGER.

FINANCIAL SUPPORT

The financial support of the experiment stations for the fiscal year 1930 exceeded that of the preceding year, as the result of increases from Federal sources, State appropriations and allotments, and other forms of income.

In Table 1 the station income from different sources in 1930 is compared with that of 1929, and also with the income of 1925, the year before the Purnell Act went into effect, to show the progress in financial support during the important period in which the Purnell appropriation reached its maximum.

TABLE 1.—*Comparison of the income of the agricultural experiment stations for the fiscal years ended June 30, 1925, 1929, and 1930*

Source of funds	1925	1929	1930
Hatch Act	$720,000.00	$720,000.00	$735,000.00
Adams Act	720,000.00	720,000.00	720,000.00
Purnell Act		2,400,000.00	2,880,000.00
Appropriations for insular stations	238,280.00	246,400.00	247,000.00
State appropriations and allotments	5,827,871.88	8,120,801.08	8,807,105.20
Fees	427,486.63	613,554.88	644,462.36
Sales receipts	1,390,480.48	1,996,470.40	1,855,356.37
Miscellaneous income	215,989.17	417,917.78	596,276.76
Balance from previous year	1,041,867.71	1,172.908.07	1,425,923.16
Total	10,581,975.37	16,408,052.21	17,911,123.85
Income 1930 over 1929			1,503,071.64
Income 1930 over 1925			7,329,147.98

For the fiscal year ended June 30, 1930, the total resources of the experiment stations amounted to $17,911,123, an increase of $1,503,071 over those of the preceding year. This total was made up of $4,582,000 from Federal appropriations (including $247,000 for the stations in Alaska, Hawaii, Porto Rico, Guam, and the Virgin Islands provided for in the appropriation acts for the Department of Agriculture) and $13,329,123 from sources within the States and Hawaii. Approximately 75 per cent of the income of the stations in 1930 was derived from State sources.

A comparison of the station income of 1930 with that of 1925 shows an increase of $7,329,147, or nearly 41 per cent. The direct Federal appropriations for experiment station work increased during this period from $1,440,000 to $4,335,000. The remainder of the increase over 1925, amounting to $4,434,148, was derived mainly from State appropriations and allotments which increased from $5,827,872 in 1925 to $8,807,105 in 1930, representing a difference of $2,979,233. Sales receipts increased $464,876 during this period, and the miscellaneous income also showed a marked growth.

The supplementary funds of the stations for the last two years, as compared with the corresponding income for the fiscal year ended June 30, 1925, are given in Table 2, which follows:

TABLE 2—*Income of the agricultural experiment stations from within the States for the years ended June 30, 1925, 1929, and 1930*

Station	1925	1929	1930
Alabama	$66,877.73	$235,781.75	$281,788.54
Arizona	100,668.70	111,871.42	102,476.55
Arkansas	93,167.67	205,326.62	131,568.65
California	635,861.21	837,135.55	948,467.03
Colorado	180,089.05	190,025.61	180,688.64
Connecticut State	103,423.30	214,437.50	237,116.45
Connecticut Storrs	56,759.92	57,272.93	60,426.89
Delaware	34,208.29	38,905.44	41,133.39
Florida	121,594.81	355,845.99	441,143.50
Georgia	21,526.45	66,953.10	64,455.50
Hawaii			55,101.53
Idaho	27,254.61	48,823.09	59,141.21
Illinois	488,872.22	531,169.40	508,403.38
Indiana	607,750.95	756,348.85	741,952.97
Iowa	344,908.78	287,699.09	306,834.09
Kansas	197,210.86	205,379.17	223,344.78
Kentucky	291,534.54	361,214.88	362,227.18
Louisiana	98,112.44	150,573.04	207,244.08
Maine	52,345.36	69,086.58	77,220.17
Maryland	103,817.93	141,554.38	134,273.23
Massachusetts	188,695.96	247,784.46	283,717.19
Michigan	284,835.47	333,414.27	365,599.18
Minnesota	403,838.90	414,498.58	406,788.00
Mississippi	193,553,34	265,451.60	174,345.24
Missouri	180,783.23	194,109.07	189,445.74
Montana	134,391.48	156,578.14	161,959.51
Nebraska	188,442.09	223,912.27	220,695.47
Nevada	3,871.71	10,066.61	11,949.66
New Hampshire	27,526.45	39,965.23	49,138.34
New Jersey	207,470.55	419,664.06	543,058.95
New Mexico	37,311.26	35,129.11	38,194.20
New York Cornell	265,039.56	349,208.97	738,235.61
New York State	262,934.00	341,868.91	351,730.51
North Carolina	202,379.11	198,663.18	209,270.24
North Dakota	264,896.12	259,351.55	257,085.10
Ohio	706,164.44	1,472,532.76	1,392,882.03
Oklahoma	27,925.42	63,354.85	175,023.54
Oregon	184,887.73	337,697.55	318,439.96
Pennsylvania	82,551.94	154,122.11	154,983.08
Rhode Island	10,147.49	16,169.28	12,461.05
South Carolina	116,081.16	157,104.06	151,640.08
South Dakota	62,167.50	61,746.91	62,000.50
Tennessee	51,431.88	65,328.22	73,720.25
Texas	385,611.63	589,061.03	720,845.27
Utah	67,438.63	78,998.00	96,776.72
Vermont	13,626.57	21,088.54	22,913.99
Virginia	88,067.31	100,218.59	110,319.48
Washington	151,683.18	190,463.01	180,422.14
West Virginia	132,422.70	149,940.77	148,720.63
Wisconsin	336,354.94	426,592.36	440,441.55
Wyoming	15,179.30	82,163.77	101,312.98
Total State support	8,903,695.87	12,321,652.21	13,329,123.85
Federal funds	1,440,000.00	3,840,000.00	4,335,000.00
Grand total	10,343,695.87	16,161,652.21	17,664,123.85

The relative rank and grouping of the stations on the basis of total income changed somewhat during the past year. While the total increase in supplementary funds was marked it was not evenly distributed, 32 stations reporting increases and 18 decreases, as compared with the amounts received in 1929. The decreases were significant in only a few instances, while in several cases the increases were substantial.

The Ohio station received State support in excess of $1,000,000. The seven stations receiving over $500,000 from within the State, in decreasing order of the amounts received, were Ohio, California, Indiana, New York Cornell, Texas, New Jersey, and Illinois. Similarly, the Florida, Wisconsin, Minnesota, Michigan, Kentucky, New York State, Oregon, and Iowa stations constituted a group reporting supplementary funds ranging from $300,000 to $500,000. Thirty-five stations received less than $300,000 and of these 13 had a supplementary income under $100,000. In only a few stations the supplementary funds, running from about $12,000 to $23,000, were devoted largely to regulatory work and did not significantly benefit the programs of investigation.

For more detailed data regarding income and expenditures of the stations see page 91.

FACILITIES FOR RESEARCH

To meet the needs of their expanding activities the stations made noteworthy additions during the year to their facilities for research in the way of buildings and land, livestock, office and laboratory accommodations, and special equipment of various kinds. They expended $1,252,390 for buildings, $65,084 for library purposes, $222,394 for apparatus, $307,645 for farm implements, $145,132 for livestock, and $296,754 for miscellaneous items, making a total of $2,289,399 for additions to their general equipment, or $225,516 more than in the preceding year.

Some of the additions to buildings, land, and other equipment of the stations reported during the year are noted in the following pages.

BUILDINGS

The building program of the stations provided improved facilities for the various lines of research at the main stations as well as at the substations and other experimental centers. The University of California completed a life science building at Berkeley at a cost of $1,750,000. This building furnishes quarters and laboratory facilities for station work in plant, animal, and human nutrition. The legislative grants to Cornell University, in which the New York Cornell experiment station is directly interested, included an appropriation of $650,000 for a new building for agricultural economics and related lines. An additional allowance of $510,000 was made for the completion of the new home economics building, and $415,000 was provided for the equipment of the recently completed plant science building and the improvement of its grounds. A new agricultural science building under construction at the New Mexico college, to cost $80,000, will provide improved facilities for station work. It has been named Foster Hall in honor of Luther Foster, a former president of the college and director of the experiment station. The University of Wisconsin completed an addition to the agricultural library at a cost of $17,500, and planned to erect a new agronomy building to cost $175,000. A new greenhouse for sugar-beet improvement work in cooperation with the United States Department of Agriculture was completed at the Colorado station.

A new 2-story and basement structure for research in animal diseases and genetics, erected at Connecticut Storrs station at a cost of $42,000, was dedicated June 12, 1930. The building was named the Atwater Laboratory in honor of W. O. Atwater, the first director of the station. The Michigan station completed a new animal husbandry barn with adequate yards at a cost of $90,000 and expended $10,000 additional for fixtures and equipment. The new poultry plant comprising a 3-story office and laboratory building, two large laying houses, and extensive poultry yards was completed during the year. A laboratory building for veterinary and bacteriological work was in course of construction, which will facilitate the work of the station along these lines, and will also house the cooperative central laboratory to be maintained by the college and station under a 3-year cooperative agreement with the National Research Council for the culture of strains of Brucella in the study of infectious abortion.

The New Jersey stations had State appropriations of $30,000 for a livestock barn, and $9,000 for several minor structures. Cornell University was granted by the State legislature $160,000 for the construction of barns and other facilities and for the purchase of additional land for animal husbandry work. The Oklahoma Legislature of 1929 appropriated for the use of the station $25,000 for a hog barn, $20,000 for a sheep barn, and $22,000 for a beef-cattle barn, including experimental feeding sheds. On the new tract of 40 acres acquired the preceding year the Rhode Island station constructed a laboratory for work in poultry diseases and animal breeding, and a series of poultry houses for egg-laying contests. The Utah station completed an animal-disease laboratory for which an appropriation of $25,000 for equipment and maintenance became available July 1, 1929; and the Wisconsin station completed during the year a feed-storage building costing $20,000.

A new dairy-development building erected on the Kentucky station farm contains butter, market-milk, and ice-cream laboratories, a cheese plant, and equipment for studying nutritional problems and diseases. The Michigan station built, at a cost of $9,000, a supplemental dairy barn for studies in breeding, feeding, and other lines with dairy cattle; and the New Mexico station completed a new dairy building costing $20,000. The Virginia college received an appropriation of $150,000 for a dairy-products building with equipment, which is expected to benefit the experiment station materially; and the West Virginia station erected a modern hospital barn for studies of the control of abortion among dairy cattle.

A number of important buildings were constructed or provided for which will aid investigation in horticulture and botany. A 2-story building completed at the Massachusetts college provides modern facilities for research in manufacturing horticultural products. At the market garden field station at Waltham additional greenhouse and laboratory space was provided for research in floriculture. The Michigan station contracted for the construction of a greenhouse for research in plant physiology and plant pathology; and the New Jersey stations received a State appropriation of $10,000 for the completion and equipment of their plant physiology building.

With an appropriation of $14,000 the New York Cornell station was to undertake the construction of an office and laboratory building at the Long Island vegetable research farm. The New York State station was granted by the legislature an appropriation of $285,000 for a horticultural laboratory building to house the division of horticulture and botany. The Pennsylvania station occupied the first wing of the new botany building, a fireproof structure with three stories and basement, which affords modern equipment and facilities for research in plant physiology and plant pathology.

Among the appropriations for capital outlay at the Virginia college, of benefit to the station, was included $30,000 for an agricultural engineering laboratory. For work on insect pests and diseases of the apple and peach the station completed at Charlottesville a field laboratory costing $3,900. The Tennessee station completed for its department of entomology a spray laboratory providing facilities for investigation of insecticides.

EQUIPMENT

Among the more important additions to station equipment reported were a laboratory set up by the Arizona station at Mesa for the study of special problems of that part of the State, and a better equipped laboratory for nutrition investigations at the central station; improved laboratory facilities for work on soils and nutrition and other household problems at the New Mexico station; a textile laboratory at the Ohio station in one of the university buildings at Columbus; a complete milling and baking outfit at the Pennsylvania station for the study of the quality of Pennsylvania-grown wheats; and field laboratories established by the Florida station at Leesburg for the study of watermelon diseases and insects, and at Pierson for the study of insects affecting ornamentals.

An experimental cotton gin and cotton warehouse costing about $6,000, and greenhouses for controlled experiments in agronomy and horticulture were built at the Mississippi station. A ginhouse and fertilizer storage house costing $5,100 was constructed at the Alabama station; and a new animal husdandry building completed during the year had an entire floor equipped as a nutrition laboratory.

Equipment of the new office and laboratory building which now provides laboratories for work in home economics and human nutrition, plant pathology, and horticulture was completed at the Georgia station. A feature of the horticultural laboratory is an installation for the production of freezing temperatures. The South Carolina station installed a series of horticultural plats with overhead irrigation, and also constructed an insectary, which, equipped, cost $4,600. The Illinois station installed a stationary spray plant for study of the design and other requirements of such installations and for comparisons of different kinds of pipe for laterals.

SUBSTATIONS AND LAND

Acquisition of land for experimental use and the establishment and equipment of substations for the study of special local problems were reported by a number of stations.

The Legislature of Texas appropriated $17,500 for land near Tyler, in east Texas, to be used for soil erosion studies in cooperation with the Department of Agriculture. A tract of 454 acres was acquired for the purpose, and the State appropriation was supplemented locally by a donation of $2,000. The Legislature also authorized the establishment of four new substations. A site of 192 acres, donated by the citizens of the winter garden region, was acquired at Winter Haven for one of these substations. With these four new substations the State will have 19 substations and 3 local research laboratories to supplement the work of the main station.

The Arizona station disposed of its lowland farm at Yuma and acquired higher land better suited for experiments. The Oklahoma station was granted by the State Legislature $24,000 for land for a substation at Woodward, and $31,000 for land for the main station at Stillwater. On the New Mexico college livestock ranch, where the station is carrying on range work, an additional well was drilled, 20 miles more of fence was completed, and other

improvements made with funds provided by the State.

Ninety acres was added to the original 160 acres of land of the cotton substation of the Arkansas station at Marianna. The farm lands of the Mississippi station were increased by 376 acres for use of the agronomy, animal husbandry, horticulture, and agricultural engineering departments. Other acquisitions of land included 300 acres for the Delta substation, 188 acres for the Holly Springs substation, 66 acres for the South Mississippi substation, and 327 acres for the newly established pecan station at Natchez. At the Delta substation $25,500 was expended for seed houses and other minor buildings, a seed house was constructed at the Raymond substation, and buildings and equipment destroyed by fire at the South Mississippi substation at Poplarville were replaced. Buildings and equipment costing $50,000 were completed at the Alabama Gulf Coast substation at Fairhope and at the Black Belt substation at Marion Junction, both recently organized. A field laboratory for fruit work was established on 7 acres of land near Mobile for which the city and county donated $7,000. The Georgia mountain substation was established on a tract of 200 acres near Blairsville for work largely with fruits and vegetables, and also for work in forestry in cooperation with the State Forestry Association.

The field laboratory of the Florida station, at Homestead, was converted into a substation for the study of subtropical fruits, and the tobacco substation at Quincy was enlarged into a general substation for studies of the principal crops of western Florida. For the use of the new substation at Homestead local interests donated to the State three tracts of land and erected an office and laboratory building.

The equipment for dairy investigations at the Sandhills substation of the South Carolina station was improved at a cost of $10,000. The Kentucky station added 113 acres to the station farm at Lexington, bringing the total area up to 600 acres, and also acquired 50 acres of additional land for the Western substation at Princeton. Improvements undertaken at this substation included a new beef cattle barn and pavilion. The Legislature of Virginia provided for the extension of research in soils and chemistry at the Virginia truck station and appropriated $30,000 for the purchase of additional land for plat work. A new substation was established at Glade Spring for pasture-improvement and forage-crop studies. A 160-acre farm at Kearneysville in the east panhandle region was acquired by the West Virginia station for work in orchard fruits and orchard management. A 200-acre farm 3 miles from the Washington station was made available for soil erosion work in cooperation with the Department of Agriculture.

STATION PROJECTS

A classified list prepared during the year showed the experiment stations to be engaged in more than 7,000 distinct lines of investigation distributed by major subjects as follows: Field crops, 1,864; horticulture, 1,224; animal husbandry, 1,015; plant pathology, 575; economic entomology, 525; soils and fertilizers, 519; agricultural economics, 463; agricultural engineering, 312; veterinary science, 284; genetics, 189; home economics, 158; dairying, 145; and forestry, 138; with smaller numbers in various other subjects. The funds available for the support of these projects amounted to about $17,000,000, approximately one-fourth of which was contributed by the Federal Government.

During the year 1929–30 there were 458 active Adams projects, which dealt with investigations of a more fundamental scientific character. These were distributed by major subjects as follows: Plant diseases, 74; soils and fertilizers, 57; entomology and zoology, 54; genetics, 51; horticulture, 41; animal production, 36; veterinary science, 36; field crops, 29; and plant physiology, 19. The $720,000 ($15,000 to each State) available from the Adams fund for support of these projects was supplemented to the extent of at least $200,000 by funds from other sources.

The 1,336 Purnell projects reported as active during the year were distributed by major subjects as follows: Agricultural economics, 338; animal production, 155; home economics, 147; horticulture, 107; field crops, 99; plant diseases, 83; economic entomology and zoology, 76; agricultural engineering, 61; veterinary science, 58; soils and fertilizers, 58; dairying, 52; and rural sociology, 41. The $2,880,000 ($60,000 to each State) available from the Purnell fund for the support of these projects was supplemented to the extent of more than $350,000 by funds from other sources.

Approximately $1,180,000, or nearly half of the Purnell fund, is now used annually for the support of investigations in economics, sociology, and home economics. Of the $9,600,000 made

available by the Purnell Act since its passage, $3,113,000 has been used for investigations in agricultural economics, $401,000 for rural sociology, and $1,194,000 for home economics, or a total of $4,708,000 for the three subjects.

Most of the work of the stations is now conducted on the basis of carefully considered and formulated projects. Especially is this true of the work supported by the Adams and Purnell funds. The tendency is to make the projects more specific as to purpose and plan, in accord with high standards of scientific research.

COOPERATION

Cooperation in agricultural research is steadily increasing. The record of cooperative projects maintained by the Office of Experiment Stations indicated that at the end of the fiscal year 1930, 1,176 of the 7,000 active station projects involved cooperation either between the stations or with one or more bureaus of the department and that somewhat over 200 new cooperative projects were put into effect during the year. These cooperative projects were distributed by subjects as follows: Plant improvement, plant genetics, cereal, forage, and other field crops, pastures and ranges, horticulture, pomology, and plant diseases, 398; agricultural economics and rural sociology, 311; animal production, animal pathology, and animal genetics, 134; soils, soil surveys, soil fertility, fertilizers, and chemistry, 88; entomology and zoology, 86; agricultural engineering, 68; dairy industry, 50; forestry, 25; human foods and home management, 10; and meteorology, 6.

All the experiment stations and the bureaus of the department have taken some part in this cooperative work. The cooperative activities of the department are confined largely to matters of national or at least regional importance, whereas the experiment stations are usually concerned mainly with such features of the undertakings as affect local agriculture. The broad viewpoint of the department, its wide knowledge of research in the subjects under study, and its large resources and research facilities often make it eminently worth while for the stations to cooperate on problems of mutual interest. On the other hand, the results of regional and national studies appear to be most useful to agriculture on a large scale if they represent the aggregate of the best information obtainable from the local sources. The ability of the stations to supply this information makes cooperative research as valuable to the department as it is to the stations.

Efforts were made during the year to establish a uniform procedure in arranging for cooperation between the department bureaus and the experiment stations, which permits preliminary and informal planning of the work by representatives of the bureau and the experiment station, but requires approval of the terms of agreement by the experiment station director and the bureau chief concerned and the Director of Scientific Work of the department. In case of cooperative projects supported by Adams and Purnell funds, approval by the Office of Experiment Stations is also required. Adherence to such a procedure, it is believed, would result in better cooperative relationships and in greater economy and efficiency in the use of research funds.

INSULAR EXPERIMENT STATIONS

The experiment stations, maintained by the United States Department of Agriculture in Alaska, Hawaii, Porto Rico, Guam, and the Virgin Islands, have continued their work under the supervision of the division of insular stations of the Office of Experiment Stations along about the same lines as previously reported. Pioneer work, that was so essential at each of these stations, is gradually giving away to studies of the more fundamental principles of agriculture that may be applied to local practices and aid in developing systems of diversified agriculture applicable to the different regions.

The incomes of the stations derived from appropriations made by Congress for the fiscal year ended June 30, 1930, were as follows: Alaska, $85,000; Hawaii, $45,000; Porto Rico, $59,000; Guam, $29,000; and the Virgin Islands, $29,000. The proceeds from the sale of products, which are deposited in the Treasury as miscellaneous receipts and are not available for station use, amounted to $4,295.72.

ALASKA STATIONS

On account of the extent of the Territory and wide differences in topography, climate, and soils it has been considered desirable to maintain experiment stations at Sitka in southeastern Alaska; on Kodiak Island, which represents fairly well the treeless southwestern region; at Fairbanks in the Tanana Valley, where the winters are long and the summers are short and hot, and where the annual rainfall seldom exceeds 14 inches; and at Matanuska, which

represents a transitional region between the vast interior valleys and the coast region.

The work of the Alaska stations was reorganized to some extent during the year, and more of the investigations were centered at the Matanuska station. The other stations are maintained as demonstration stations or for carrying on some of the simpler experimental projects. The plan of placing all the livestock work under the animal husbandman of the Matanuska station proved to be so advantageous that arrangements were made to concentrate the research work in agronomy in a similar manner. The agronomist of the Fairbanks station visited the Matanuska station during the year, reviewed the experiments in progress and, in cooperation with the director of the Alaska stations, worked out a plan for the unification of the experimental work in plant breeding, crop rotation, and plat work with cereals and forage plants. These activities will be under the immediate supervision of the agronomist in charge of the Fairbanks station, as is the animal husbandry work under the direction of the animal husbandman of the Matanuska station.

The work at the Sitka station has been reduced materially. During the past year it was confined almost wholly to small fruits, vegetables, ornamentals, and lawn management. Southeastern Alaska does not possess many large tracts capable of agricultural development, and the principal problems in that region are connected with home gardens and home development. It is quite evident that the majority of the white population of the Territory will for some years be located in that region, and the station at Sitka is planning its work for the benefit of the home makers. The station continues to be a source of planting material for southeastern Alaska as well as for other parts of the Territory. Varieties that have been found adapted to the country are produced to a limited extent for cooperative testing by settlers.

At the Fairbanks station the work is mainly with cereals, root crops, and forage plants, the experiments being directed toward the production of crops that will mature within a frost-free period of slightly less than 100 days. Very good progress has been made along some lines, and the station has produced varieties of wheat, oats, and barley that not only mature within this period, but their yields are well above the average for these crops in other parts of the United States.

The Fairbanks station has been engaged since 1915 in an experiment to produce for the interior of Alaska a hardy beef animal through the crossing of the Asiatic yak with Galloway cattle. Progress has been very slow by reason of the limited number of breeding yak, yet the work has proceeded far enough to show the great hardiness of the crossbred animals and their ability to pass through the winter on a very limited ration of coarse roughage to supplement the feed secured on the range. Through the cooperation of the Canadian Government the station was able to add to its herd a young bull and three heifer yak during the year. With the increased number the crossbreeding should proceed more rapidly. Thus far all the first-generation males of the yak-Galloway cross have been sterile, whereas the females have bred regularly. With the number of animals now in the experiment reciprocal crosses will be compared, not only among themselves but also with pure strains.

At the Matanuska station the work is more diversified than at any of the other stations, and it includes animal husbandry, dairying, agronomy, and horticulture.

In animal husbandry one of the leading projects is the production of a hardy milk cow by crossing the Holstein and Galloway breeds. Purebred herds are maintained for comparison. During the past year the best crossbred cow produced in the first 100 days of her lactation period 5,552.5 pounds of milk as compared with 4,993.9 pounds for the best Holstein in the herd. Both cows freshened at about the same time, and they received the same care and feeding. One crossbred heifer produced during her first lactation period 10,109.8 pounds of milk, with an average butterfat content of 5 per cent. The crossbred animals are as hardy as the Galloways. Genetical data are being secured on all the animals. In connection with this experiment, and as an aid to settlers, the station is cooperating with the Alaska Railroad, which has established a creamery at Curry and buys cream delivered at any station along its route. Other livestock work in progress is concerned with the breeding, feeding, and care of swine, sheep, and poultry.

The Alaska Railroad has entered upon an active campaign to secure settlers along its line, especially in the Tanana and Matanuska Valleys, and in order to reduce the costs as much as possible the experiment stations are

engaged in cooperative work on clearing and preparing land for cropping.

The work on Kodiak Island is carried on at Kalsin Bay some 15 miles from the village. The principal experiment consists of the maintenance, under range conditions, of a small pure-bred herd of Galloway cattle to determine the methods of winter management. This island, which is representative of the treeless region of the Alaska Peninsula and adjacent islands, has abundant summer pasture, but by reason of the heavy rainfall and many cloudy days haymaking is very uncertain. The solution of the wintering problems, not only for cattle but also for sheep, will mean much for this region.

HAWAII STATION

Upon the extension to Hawaii of the acts granting Federal aid to the agricultural experiment stations on May 16, 1928, a cooperative agreement was entered into between the Department of Agriculture and the University of Hawaii whereby the experiment stations formerly maintained by each were combined into a single institution under the joint control of the cooperating agencies, with the former director of the Federal station in charge.

The first year of the joint control passed very satisfactorily. The property of each unit is kept separately, but there has been considerable pooling of interests, personnel, and facilities for research, with an increase in efficiency and a reduction of administrative expense. The enlarged station has for its support the direct appropriations made by Congress, the Hatch and supplementary funds, and Territorial and other funds.

Under the cooperative arrangement, the horticulture, chemistry, and soils projects that have been in progress for several years at the Federal station were continued with the same leadership, and the agronomy work was expanded by the inclusion of a number of projects that have been supported by the university. The animal husbandry work begun by the university was continued and considerably enlarged. The projects on feeding dairy cows and swine were broadened, and studies of a number of poultry problems of great local importance were begun. In soil physics a study of the factors which affect the capillary rise of water and its movement in colloidal soils was begun. A nutrition laboratory was equipped, and studies of the vitamin content of Hawaiian fruits and vegetables as compared with those received from the mainland were undertaken.

Among the more important investigations of the station have been those relating to mango, Macadamia nut, and papaya culture in Hawaii; composition and use of oriental vegetables in Hawaii, physical properties of Hawaiian soils, the edible canna as a source of starch, and the management of baby chicks in confinement. These investigations have yielded results of much scientific interest and practical value.

Special investigations are in progress on the native raspberry, or akala as it is known. This plant bears a fruit 1.5 to 2 inches in diameter and appears to offer opportunities for domestication as well as for crossing with other varieties.

The station has established a field laboratory in the Kona district of Hawaii for studies on the coffee industry. From the work of the substation at Makawao, Maui, valuable information is obtained on the adaptability of crops to elevation of 3,000 feet or more.

PORTO RICO STATION

D. W. May, for nearly 26 years director of the experiment station at Mayaguez, retired under the provisions of the Federal retirement act relating to service in the Tropics. Under his supervision the number of station workers was more than doubled, and the income of the station was increased nearly fourfold. In addition to his administrative duties, Mr. May was actively associated with many of the station's activities, especially those pertaining to livestock improvement and management, sanitary dairying, tick eradication, forage-plant introductions, and the reforesting of denuded lands.

Mr. May was succeeded as director on May 1 by George F. Freeman, formerly connected with the Kansas, Arizona, and Texas experiment stations, and at the time of his appointment director general of the Service Technique, Haiti. Before going to Haiti Doctor Freeman was engaged in cotton-breeding work in Egypt and in a survey of Indo-China as a possible cotton-producing country. Doctor Freeman entered upon his new duties with great earnestness and vigor, but unfortunately he died suddenly on September 17, 1930. He was succeeded as director by Thomas B. McClelland, for 20 years in charge of the horticultural work of the station.

C. M. Tucker, for nearly seven years plant pathologist of the station, resigned April 15 to accept a position with the Florida station.

The work in animal husbandry and dairying formerly under the supervision of Director May, was taken over temporarily by H. L. Van Volkenberg, parasitologist of the station.

The major projects of the station were continued without much interruption.

The permanent horticultural plantings were damaged severely by the hurricane of September, 1928, and they are being restored slowly. Immediate attention was given the trees after the storm, but some were so injured that they failed to recover. Several years must elapse before the new plantings made are in full bearing.

The horticulturist, who had devoted much time to studying problems connected with coffee production, was in a position to give valuable assistance in the restoration of coffee plantations. Large quantities of coffee seed, especially of the Excelsa variety, were supplied for the establishment of seed beds, and advice was given on shading, pruning, etc. The coffee plantations in the vicinity of the station are reported as rapidly coming into normal condition. The horticulturist also served as adviser on the planting of emergency food crops. The results of station work have shown the practicability of the production of more foodstuffs, and the station is in full accord with the program of the governor in the growing of many foods that are now imported.

The plant-breeding work is progressing satisfactorily, especially that with sugarcane. From many thousands of seedlings of known origin that have been grown, a few outstanding ones of good agronomic characters and high sucrose content and resistant to mosaic are being compared with standard varieties grown under plantation conditions.

The investigations carried on for the benefit of growers of citrus fruits and pineapples have yielded important results that are being put into practice. Largely as a result of the station's work with fruits, a commercial precooling plant was erected at San Juan, and the fruit is reported as reaching New York in better condition than formerly. Preliminary results seem to indicate that within rather definite limits the time of maximum blooming and fruit setting of citrus trees can be controlled by the application of fertilizers at certain periods.

The parasitologist is actively engaged on a study of internal and external parasites of livestock, especial attention at this time being given to the internal parasites of cattle, particularly of calves. Considerable study is being made of life histories of the parasites in an effort to discover means for their control.

GUAM STATION

The Guam station was able to resume its extension activities that were suspended in 1921 on account of lack of funds. A small increase in the station funds made it possible to appoint Antonio I. Cruz, a native of Guam, who was partly educated in the States and graduated from the University of Hawaii. He entered upon his new duties in September, 1929. The reorganized work consists of boys' and girls' clubs and adult demonstrations. The clubs organized embrace eight activities, rice, corn, copra, horticulture, root crops, home gardens, pigs, and poultry. The club memberships at the end of the fiscal year totaled 863. This work, which is carried on in cooperation with the local department of education, is supervised closely, and its reestablishment has met with the approval of the people of the island. The extension work with adults consists mainly of cooperative projects with farmers, so planned as to make practical application of the results of the station's investigations. The resumption of this work has enabled the station to maintain closer contacts with the farmers of the island than were possible without it.

The efforts to improve the livestock of the island by the use of purebred sires are giving excellent results. The station now has a creditable herd of grade Ayrshire cattle, purebred and grade Duroc-Jersey pigs, and purebred and grade White Leghorn chickens. The surplus stock is sold to ranchers for breeding purposes.

The poultry-breeding experiment, in which an attempt was made to combine the size and hardiness of the native stock with the egg-laying qualities of the White Leghorn, is giving some very promising results. Only an occasional fowl that is not solid white in color or that lays a brown egg is to be found in the station flocks. The demand for eggs of this new strain for hatching exceeds the surplus supply.

Livestock production in Guam is attended with numerous difficulties, among them being heavy infestation of parasites. The station has had some very satisfactory results from its work on parasite control, especially with poultry. Carbon tetrachloride administered with coconut oil has been found effective against roundworms of poultry, and of considerable benefit against tapeworms. A deficiency disease of

cattle and carabao grazing on the savannas, or red-clay uplands of the island, was controlled in most instances by feeding bone meal.

Experiments with copra meal continued to give satisfactory results when it was fed as a part of the ration for all kinds of stock. This is fortunate, as a commercial mill has been established on the island for the extraction of the oil, and a considerable quantity of meal can be obtained at a reasonable price.

In connection with the livestock-improvement work, the introduction and testing of forage plants has had a prominent part in the station's program. As a result of five years' tests of a number of grasses, Napier and Guatemala grasses appear to be the most widely adapted for growing for stock feed.

Various leguminous plants are being tested for forage, soil improvement, and weed control.

Previous work of the station was devoted to determining what truck crops could be grown successfully in Guam, and present efforts are to determine the varieties of these crops adapted to local conditions. Considerable selective-breeding work is in progress to secure improved varieties.

The entomologist continued his efforts in introducing, breeding, and distributing insect parasites and predators with promising results. The European corn-borer parasite, *Exeristes roborator*, introduced from the States through the cooperation of the Bureau of Entomology of the Department of Agriculture, has failed to come up to expectations. Although bred and distributed in considerable numbers, only a few have been recaptured in the field. The results of this trial have led to attempts to secure other parasites, and arrangements have been made to receive parasites from the Bureau of Entomology agent in Japan. The breeding and distribution of parasites of house and stable flies has resulted in the parasitizing of from 75 to 80 per cent of the fly pupae, thus greatly reducing the number of pests. The parasites are so abundant about the station premises that supplies for distribution can be secured at any time.

VIRGIN ISLANDS STATION

A severe drought, extending over parts of 1929 and well through 1930, seriously affected the work of the Virgin Islands station. The production of sugar on the island of St. Croix for 1930 is estimated at less than 6,000 tons as compared with 12,000 tons in 1928, a favorable year.

In the Virgin Islands so much dependence is placed on stored water that the station increases its supplies whenever possible. During the year additional catchment areas and an additional cistern of 30,000-gallons capacity were added to the water-storage system.

The appointment of a veterinarian, who also acts as animal husbandman, has greatly increased the activities of the station. Appointed to fill an urgent need in connection with the certification of cattle intended for shipment to Porto Rico, the veterinarian has been placed in charge of the quarantine work of the islands. Inspections were made of 536 animals imported, and certificates were issued for the export of 1,225 cattle. Interest was aroused in the control of cattle ticks, and 5,326 cattle were passed through dipping vats during the year. The veterinarian supervises the dipping of the cattle, testing the dipping solutions from time to time to insure their safety and efficiency.

A test of 12 seedling sweetpotato varieties on a field scale in comparison with the best local variety showed that seedling variety No. 794 yielded about 60 per cent more sweetpotatoes of better quality than the variety usually planted. From the thousands of sugarcane seedlings grown at the station, several varieties obtained give promise of increased yields over S. C. 12/4, a station product that is now the dominant variety of sugarcane grown in St. Croix. Many of the new varieties are progenies of S. C. 12/4, and they show a high sucrose content. A large number of varieties of forage plants have been planted to test their value in the Virgin Islands, especially for their ability to produce under limited and uncertain rainfall.

The horticultural work was mainly with fruits and vegetables. A large number of introductions were made for testing under local conditions, and some promising varieties were secured for further work. With vegetables, cultural and variety tests were made as a basis for recommendations for local growing. An experiment in growing onions, tomatoes, peppers, and eggplants for shipment to New York during the winter was not a financial success owing to drought retarding the crop until low prices prevailed in the New York market. A plantation, cooperating with the station, grew 13 acres and harvested 220,000 pounds of Bermuda onions. Late rains caused many splits and oversized bulbs. As New York prices were low the crop was sold in the West Indies, and the receipts

were somewhat more than the cost of production and shipment.

A considerable number of tropical and subtropical fruits were introduced during the year, and an experimental planting of vinifera grapes on St. Thomas appeared very promising.

The extension and demonstration work on St. Thomas and St. John continued to make progress. In addition to the grape work mentioned above other introductions were made, some of which appear promising. Some attention was given to canning fruits and vegetables to utilize surplus products and to furnish a supply of them in seasons when the fresh products are not to be had. Marked interest was manifested in this work, and a number of persons signified their intention to plant larger areas for marketing and canning.

Toward the close of the fiscal year an economic situation developed in St. Croix that seriously threatened the agriculture of the island. Drought conditions, resulting in the prospect of a poor crop in 1931, led the largest sugar-producing company to cease all operations, which threw many laborers out of employment. Efforts were being made to have these people grow some of their food. Individual families were permitted the use of land in small plats, and so far as possible the station was cooperating with local authorities to relieve the situation.

WALTER H. EVANS.

SOME RESULTS OF STATION WORK

From the large volume of reports of station work during the year, specialists of the Office of Experiment Stations have selected a limited number of contributions for the preparation of the following reviews.

SOILS AND FERTILIZERS

The topics here considered are, in general, the same as those included in last year's review. The work noted, however, represents, in certain instances, important advances.

Infertile soils and toxic soil components.—Under this head will be taken up soils unproductive by reason of exhaustion of natural fertility, lands barren because of alkali conditions, infertility resulting from leaching and erosion, and the occurrence, also, in certain soils of substances poisonous to plants.

Further investigation of exhausted lands by the New Hampshire station has shown that these soils still contain available phosphorus sufficient for crop production. Nitrogen and potassium were found to be needed, however. Hay yields on unmanured land were increased significantly by the use of sodium nitrate. Yields of potatoes were maintained by a fertilizer mixture containing 10 per cent of potash and applied at the rate of 1,500 pounds to the acre. Similarly, by applying a complete fertilizer and lime, the Indiana station obtained satisfactory yields of corn, wheat, soybeans, and mixed hay from a very light sand which had been abandoned as useless.

Erosion infertility was studied by the Indiana station in fertility experiments made on subsoils from 6 to 15 inches below the surface. Erosion of the principal Indiana soils was thus found likely to expose layers very deficient in nitrogen and phosphorus, and to a lesser degree in lime and in available potassium. Cropping methods for the prevention of erosion have been reported from the Missouri station, and the Texas station has continued its work on choice of crop and terracing as preventive measures. Both of these stations have studied, also, the relation between erosion and the type and extent of the rainfall.

Correctives for alkali soils are still under investigation by a number of stations. The Wyoming station has shown tschermigite, a natural ammonium alum, to improve the physical condition of an alkali soil by rendering it much more friable and more readily permeable. The Idaho station found slick-spot soil to have a replaceable base content greater than that of an adjacent normal soil. Both in the slick spots and in the surrounding normal soils, however, replaceable calcium was high and sodium low. The upper horizon was low in replaceable bases, and the second very high, followed by a decrease with increasing depth.

A loose sand, low in silt and clay, and free from electrolytes, was observed by the Florida station to be favorable to the formation of an organic hardpan of relatively high aluminum content wherever the water table is near the surface (from 6 to 36 inches below) during part of the year. Approximately one-half of the 35,000,000 acres of land in Florida was found to consist of "flatwoods" soils, low in agricultural value by reason of such a hardpan.

Finely chopped buckwheat roots introduced into the soil were shown by the Rhode Island station to produce a toxic substance. The toxic effect

increased as the roots decomposed. A variety of experiments indicated in each case a distinct depression of growth following the introduction of the toxic substance into the soil. The Ohio station observed a blackening of the soil by leaking natural gas and a reduction of the higher oxides of manganese to a form which increased the exchangeable manganese content of the soil. Restoration of good aeration oxidized the excess exchangeable manganese and permitted the resumption of good plant growth. The Rhode Island station showed that active soil aluminum could be reduced by ordinary field applications either of phosphates or of lime.

Soil reaction and its modification.—Seasonal fluctuations of the soil reaction sufficient to affect tobacco production have been demonstrated by the Connecticut tobacco substation. Two years' measurements showed the reaction to be highest in December, lowest in June, and of a total range of from 0.5 to 1 pH unit. A soil pH value a little above 6 appeared to be preferable at the New Jersey stations to a pH value below 6 for beets, carrots, and other crops. A pH value of 7 or even a slightly more alkaline reaction appeared to do no harm. The Missouri station could find no adequate justification for the division of soil acidity into a variety of classes on the basis of reactions with various salts.

Limestone ground coarser than 20 mesh, according to the results of the Alabama station, reacted very slowly in soils of medium or even of high acidity. Limestones of from 20 to 60 mesh grinding reacted much more rapidly.

Moisture and related physical factors.—Recent work of the Arizona station indicates a moisture film continuous from the soil to growing plant at all soil moisture percentages above the wilting point. The plant appeared able to carry moisture from any soil horizon (e. g., the subsoil) to a drier horizon (e. g., a dried surface soil), there to exude the water thus transported, and through its means to take up nutrients from the drier soil. These experiments indicated also a continued transfer of nutrient ions even after all movement of soil water has ceased, the plant thus being able to absorb nutrients from a soil maintained at the wilting percentage of moisture. The same work showed, further, that soil moisture is available to plants when held by the soil with a force less than that of about five atmospheres. Soil-moisture phenomena have been analyzed mathematically in a contribution from the Utah stations.

Work on other physical factors of soil behavior has included the determination by the Nebraska station of the Atterberg consistency constants of a number of soils; the observation by the Missouri station that colloidal clay saturated with calcium has particles larger and less highly hydrated than those of the same soil material saturated with the monovalent cations, an effect constituting good reason for the use of lime to maintain a good soil structure; and a study of the cataphoresis, flocculation, and dispersion of soil colloids, contributed by the New Jersey stations.

Mineral nutrients and base exchange.—From a four years' investigation of practically all the important soil types of the State the Connecticut State station concluded that the soil type is in general less important in determining immediate nutrient requirements for crop production than is the past history of the field. Differences in the physical character of the soil were shown, however, to be of great importance in determining under field conditions the economic response to fertilizers and to liming.

The Rhode Island station has shown that a prolonged course of superphosphate treatment has but little apparent effect in satisfying the phosphate-absorbing power of a soil of the local type. Phosphate fixation was studied also by the California station, where a peat soil showed apparently both precipitation and absorption of phosphate from its solutions. The phosphate fixation observed above pH 2 could be accounted for as a formation of the phosphates of iron, aluminum, and calcium, but an appreciable fixation was shown to take place below pH 2. Only the water-soluble calcium of the peat appeared to fix phosphate. The calcium content of the replaceable base complex was found without phosphate-fixing effect even when the exchange complex was calcium saturated. Certain soil molds, also, were observed by the Iowa station to absorb phosphate both from solution and from soil culture. Of 20 mold cultures, only 2 failed to show a definite phosphate assimilation.

Comparing sources of phosphorus, the Pennsylvania station observed that both yields and net returns increased with applications of rock phosphate and of superphosphate, in conjunction with nitrate and potassium treatments, up to 600 pounds to the acre. Doubling and tripling the rock phosphate application increased the yields, and the net return nearly equaled those obtained from superphosphate. Using sulphur with the rock phosphate increased both yields and profits.

The proportion of the potassium content of a red-clover crop lost by leaching was reduced at the Tennessee station by the addition either of dolomite or of limestone when the crop was turned under.

Sulphur failed, in tests conducted by the Texas station, to increase profitably the yields of crops. On a dark calcareous soil at the Temple substation sulphur failed to control cotton root rot. The effective use of sulphur with rock phosphate at the Pennsylvania station has already been noted (p. 18).

Investigation by the New York Cornell station of some effects of fertilizer treatments and of cropping on exchangeable soil calcium and potassium showed that the quantity of exchangeable calcium held in the colloidal complex of the humid soils examined depended more upon the calcium-absorbing power of the soil treated than upon the rate of liming. Evidently the hydrogen-ion concentration of a soil containing either native or applied calcium carbonate or lime was not, therefore, even a relative index of the exchangeable calcium content. Potassium chloride in no case increased the exchangeable potassium content of this soil. At the same station aluminum was adsorbed by soil of which the alumino-silicate base-exchange complex had been saturated either with hydrogen or with calcium, and only minute portions of this aluminum could be removed by electrodialysis. The added aluminum appeared under certain conditions to become a part of the alumino-silicic base-exchange complex. When potassium, calcium, and magnesium compounds were applied together to the soil, a greater proportion of the potassium was taken up than of the calcium, and more of the calcium than of the magnesium. Effects of fertilizers and cropping upon the base-exchange phenomena were studied also in certain limed and unlimed soils by the Ohio station. The exchangeable calcium content of the unlimed soils was increased by all calcium compounds used, sodium nitrate tended to conserve accumulated calcium, but ammonium sulphate caused a heavy loss. Exchangeable potassium was little affected except by fertilizers containing this element. Similar work has also been done at the New Jersey stations.

The effect of irrigation on replaceable bases in the soil was investigated by the Arkansas station. At the Missouri station an electrodialysis of colloidal clay showed a complete recovery of absorbed phosphate to be very slow. This station also found certain physicochemical properties of clay soils to depend upon the active ion load of the particle, calcium and magnesium being important in the production and maintenance of good soil structure.

The Ohio station, comparing the reactions of electrodialyzed humus with those of a bentonite similarly treated, found the humus preparation to possess an adsorptive capacity about seven times that of the mineral-exchange complex. Soil organic matter was also observed by the Arizona station to have a marked base-exchange capacity. In highly organic soils the base-exchange capacity was found to approximate a linear function of the percentage of carbon in the soil.

Nitrogen and soil organic matter.—Sources of nitrogen have been compared by a number of the stations. The New Hampshire station found sodium nitrate better than ammonium sulphate for potatoes and showed that a mixture of the two was better than either alone. The Nebraska station found that in addition to their effect upon yields of wheat, ammonium sulphate and sodium nitrate increased the protein content of the grain, the nitrate again showing the larger effect. Ammonium sulphate was not especially effective as a top-dressing for wheat on certain of the heavy-textured soils of Nebraska, however, and in some cases sodium nitrate was found capable of harmful physical effects. Here again a mixture (a nitrate with urea) seemed to show some promise of a result better than those obtained from single salts. Even on fertile soils the New Jersey stations found sodium nitrate and ammonium sulphate able to influence plant growth. The addition of either nitrogen carrier mineralized a part of the organic nitrogen of the soil.

The Rhode Island station has shown that the nitrate contents of both plant and soil are correlated with the yields, whereas the ammonia and the amino nitrogen fractions of the nitrogen content of the plant varied rather with climatic factors and with the environment than with the fertilizer nitrogen added. In a further study of weather-nitrogen relations with special reference to the relation of soil-nitrogen content to the precipitation-evaporation ratio, the Missouri station found that the average nitrogen content of grasslands in both temperate and subtropical regions increased logarithmically with humidity factors. In the temperate region the carbon-nitrogen ratio was found not to vary with the humidity.

Nitrites appeared in abundance in cultures of the Texas station to which had been added ammonium sulphate

and a soil-extract inoculant. Nitrites appeared also in cultures without added nitrogenous material. Soils incapable of nitrifying ammonium sulphate also produced in some cases large quantities of nitrites. Nitrites were produced from urea in certain soils; and the nitrites were found much more stable than has generally been supposed. In cultures considerable nitrogen persisted in the nitrous form for six weeks, and in soil extracts remained practically unchanged for more than one week. In very small quantities, nitrites were found both in the field soil and in the laboratory samples examined. For the production both of nitrates and of nitrites 50 per cent of the water capacity of the soil was found the most favorable moisture content. Both nitrous and nitric nitrogen were produced from ammonium sulphate more readily after the addition of calcium carbonate or of magnesium carbonate.

The addition of fresh sugarcane trash rapidly and markedly reduced the nitrate content of the soil at the Louisiana station, although the change was usually accompanied by a slight gain in total soil nitrogen. At the Florida station the leaves of *Crotalaria striata* produced the most rapid accumulation of soil nitrates, the entire plant and the stems and roots following in decreasing order. The stems and roots drew, in the early stages of their decomposition, upon the nitrates already present in the soil.

A nitrogen-fixation experiment of the Massachusetts station yielded the observation that five years of continuous cropping without a leguminous crop had not reduced either the dry-matter yield or the nitrogen content of the crops.

Comparison by the Rhode Island station of sources of organic matter showed a combination of a manure-compost treatment with a green-manure crop to give as high yields as did twice the quantity of the compost without a green-manure crop. Pot experiments of this station placed onions, spinach, and lettuce in a group highly responsive with respect to soil organic matter, while beets and carrots had a lower requirement.

Work on the composition of natural organic materials and their decomposition in the soil was extended by the New Jersey stations to include anaerobic decomposition. The results furnish an explanation of the natural formation of peats of two distinct types.

The Florida station has found it practically impossible to build up the organic-matter content of the soil by means of summer cover crops alone. A comparison by the same station of burned-over land with the soils of an island which had escaped burning over for 42 years indicated a loss from the burning of more than 120,000 pounds of soil organic matter from each acre.

Soil microbiology.—Neither soil-nitrogen fixation nor the distribution of Azotobacter was affected, in the work of the Massachusetts station, by the growing of leguminous or nonleguminous crops. The hydrogen-ion concentration was also shown not to be the controlling factor in the activity of this organism. Nitrogen fixation was correlated with the presence of a strain of Azotobacter capable of effective nitrogen fixation in a nitrogen-free culture medium. Experiments at the Wisconsin station with 12 cultures of Rhizobia indicated that this root-nodule organism does not fix nitrogen in pure culture. This station also observed that *Bacillus radicicola* could fix no nitrogen in the absence of the host plant.

Bacterium globiforme was shown by the New York State station to be unable to develop in sterilized Volusia silt loam without supplementary nutrients, whereas it grew vigorously in the same soil when 1 per cent each of ammonium sulphate and glucose were supplied. The organism was found able to utilize a wide range of sources of carbon and nitrogen. Several organisms isolated by the New Jersey stations were able to decompose actively certain of the hemicelluloses. These stations found also that the growth of the higher plants stimulated the growth of the microorganisms, especially the Radiobacter group, in the immediate neighborhood of the plant roots.

The Utah station reports that, in soil artificially rendered saline, leaching increased the bacteria to more than double, more than tripled the ammonifying power, and multiplied the nitrifying power by more than 30, and the nitrogen-fixing capacity by more than 3.5. A naturally saline soil yielded after the leaching 31 organisms, of which 11 were capable of nitrogen fixation.

Methods and apparatus.—An investigation by the Connecticut State station covering several hundred Connecticut Valley tobacco fields demonstrated a close relation between pH values and lime requirements in soils of approximately the same texture and content of organic matter. Either an increase in the content of organic matter, however, or a heavier texture of the soil increased the lime absorption factor—i. e., the quantity of lime necessary for a reduction of acidity equivalent to a unit increase in pH value. This factor,

constant for each individual soil, determined the quantity of lime necessary for the production of a given change in pH value. The Iowa station found titrations of soil suspensions in calcium chloride solution with calcium hydroxide or in sodium chloride solutions with sodium hydroxide to give an indicated lime-requirement figure from two to three times that given by calcium hydroxide titration of the water suspension. This higher figure was, in general, much nearer the quantity of lime actually required in the field than was that indicated by the simple calcium hydroxide titration.

Absorption of cations continued in the case of strongly alkaline solutions after the inflection of the titration curve, in the experiments of the Missouri station on the determination of the saturation capacity of colloidal clay. The experimental conditions required careful definition, therefore, to permit the determination of comparative values. Further, the inflection point itself could be shifted by the addition of neutral salts. In determining calcium, the Maryland station avoided the loss of a part of the calcium, liable, under certain conditions, to adsorption in the precipitated hydrated oxides of iron and aluminum, by boiling to expel all the ammonia after the precipitation of the iron and aluminum. Double precipitation of iron and aluminum was rendered unnecessary, according to these results, by expelling all ammonium hydroxide from the solution after the removal of ions capable of precipitating the calcium ion.

The Winogradsky method for determining soil deficiencies was compared with that of Neubauer by the Colorado station. A very close correlation was obtained, and the Winogradsky method was found reliable enough to warrant its recommendation as a routine procedure for the testing of phosphate, potassium, and lime deficiencies in soils.

For the determination of the nature and quantity of the organic matter of the soil, a method developed at the New Jersey stations determines the fractions, (1) substances removable by successive extractions with ether and alkali, (2) a carbohydrate fraction determined as reducing sugars of acid hydrolysis, (3) a proteinaceous fraction calculated from the nitrogen determination, and (4) a lignin-humus fraction calculated from the carbon and nitrogen contents of the residue remaining after the acid extraction made in the determination of the reducing sugars of acid hydrolysis.

A new and larger soil solution displacement apparatus has been designed and tested at the California station. This equipment was found to save much labor without undesirable effect upon the results. Friability as a soil property was given a precise definition as the result of experiments at the Utah station, and preliminary values were determined by means of an instrument devised for that purpose. An index of friability was expressed in terms of the moisture percentage together with two parametric constants characterizing the soil. The methods for making morphological observations on the soil profile have been discussed in a review article from the New Jersey stations. At the Michigan station a method for the comparative measurement of the percolation rate of water in soils has been devised.

For the determination of nitrates in plant juices the Rhode Island station has revised the Gilbert method, contributed from the same station, with appreciable improvement in its accuracy. The phenoldisulphonic acid laboratory method for determining soil nitrates has been so modified by the Nebraska station as to make the procedure available for field tests. From the New Jersey stations has been contributed a procedure for the determination of inorganic nitrogen in dried plant tissue.

HENRY C. WATERMAN.

FIELD CROPS

Advances in agronomic research at the experiment stations were manifested in improved varieties of field crops, more effective methods of supplying the cultural and fertilizer needs of crop plants, a better understanding of the interrelations of the several crops and of the factors underlying the growing of quality products, and refinements in weed control.

CULTURAL PRACTICES

Efficiency in cultural method and field practice continued to be the aim of many agronomists.

Cereals.—Cultural tests by the Nebraska station demonstrated that the highest corn yield is had with three plants per hill, although considerable irregularity evidently could occur in the stand without affecting yield materially. In planting tests during 20 years, the Ohio station obtained the maximum yield of dry shelled corn from mid-date (May 7) plantings, whereas the crop quality was lower and the stover yields rose as the planting date became later. Beginning at the early dough stage and at five

weekly intervals thereafter, the yield of shelled grain and the test weight rose with each week's delay in harvest.

Spring wheat cropped continuously by the Wyoming station cooperating with the United States Department of Agriculture averaged about 10 bushels per acre, regardless of the tillage method, although the yield decreased with fall plowing. Cornland or potato land prepared with the duck-foot cultivator and fallow were about equal in spring-wheat production, and all surpassed continuous cropping. The highest yields resulted from seeding the wheat on bean land prepared with a duck-foot cultivator, a practice apparently adapted to extensive production. This station found oats spring seeded upon disked corn or potato ground very profitable in dry-farming sections and that oats gave good returns on the irrigated lands when seeded on potato or sugar-beet ground. Oats yields were increased greatly by using a rotation of alfalfa, potatoes, and oats.

Wheat, oats, and barley left standing for four weeks after ripening at the Dickinson, N. Dak., substation lost little in yield and test weight in the first week, but thereafter an increasing loss occurred in both qualities. Ceres wheat lost slightly less than Marquis or Nodak durum, and oats lost more from shattering than did wheat or barley.

Cotton.—Increase in stand up to an average of 51,000 cotton plants per acre, the Arkansas station found, enhanced the flowering rate in the first three weeks of blooming. Thick spacing appeared to increase the first picking of some cottons more than others but did not overcome the lack of productivity in a poorer-yielding variety. With favorable conditions throughout the growing season, cotton could adjust itself to a wide range in stand. Recommendations were for two to three plants a hoe width apart on all lands, with rows 3.5 to 4 feet wide on rich land, 3 to 3.5 feet apart on land of medium fertility, and closer than 3 feet on poor land.

Cultural tests with cotton, corn, and grain sorghum since 1918 by the Texas station indicated that the main value of cultivation is destruction of weeds, and that cultivation enough to keep down weeds is the best kind of tillage. In similar tests, cotton making the largest acre yield had received three cultivations, and the yield decreased somewhat with further cultivation. Uncultivated plats with weeds undisturbed produced only 42 pounds of lint, compared with 520 pounds from similar plats with weeds hoed off.

For harvesting cotton the Texas station found the commercial stripper more efficient than a modified finger type stripper or single-slot type stripper, gathering 560 pounds of picked cotton per hour in cotton yielding one-half bale per acre on upland soil. Machine-harvested cotton graded lower than comparable hand-picked cotton, largely because of the small amounts of leaf and boll trash, which the cleaning equipment at the gin could not remove completely.

Potatoes.—Early potatoes at the Ohio station's Hamilton County farm mulched at planting with 10 tons of straw per acre averaged 17 bushels more than untreated areas, and mulched when plants were up, 61 bushels more. It was suggested that mulching may prove practical if straw is available at a reasonable value. The saving in labor of cultivation is largely offset by the work of handling the straw. The Florida station found that excelsior mulch on potatoes resulted in nearly 60 per cent more yield, and it depressed soil temperatures early in the fall from 8° to 15° F.

The individual seed stock had a greater influence on yield than the locality where grown in Maryland station tests. The health and vigor of the potato seed stock seemed to be the prime factor influencing its productivity. Potato-seed-stock studies by the Nebraska station, especially with Triumph, indicated that the production of good seed need not be confined to western Nebraska. In the absence of disease, irrigation was not a factor in the production of good seed potatoes. However, when spindle tuber was present in seed stocks, irrigated seed potatoes degenerated as to productivity and quality much faster than did stocks grown on dry land and increasingly with each additional year of irrigation.

Seed potatoes greened or warmed before planting to hasten germination gave better stands and stronger plants at the Ohio station than seed direct from cool storage. The yields also increased with the warmer storage. In certain seasons warming seed potatoes before planting seemed to be decidedly advantageous. The definite effects derived from green sprouting potatoes by the New York Cornell station included a more rapid emergence, a reduction in stems per plant, an increase in stolons per stem, and a higher percentage of United States No. 1 yield per acre.

Storage losses, stands, and yields at the West Virginia station showed that removing sprouts from improperly stored potato seed stock increases loss

from decay in storage, reduces the field stand of plants and lowers their vigor, and decreases the yield of prime tubers and total yield. However, the Indiana station observed that when sprout removal induces general sprouting the reduced vigor resulting from sprout removal is more than offset by increased yield due to a better stand.

Ethylene chlorohydrin treatments effectively terminated the rest period of potatoes at the Nebraska station and caused prompt germination in fall and early winter. The more mature tubers and those stored in warm places responded quickest. Treating cut sets with a 5 per cent solution of ethylene chlorohydrin stimulated emergence in all seed treated.

Sweetpotatoes.—The Georgia Coastal Plain station found that one-fourth of the vines on sweetpotato plants could be cut away without detriment. Yields of marketable roots were in inverse proportion to the amount of vines cut away. Whole sweetpotatoes as seed produced a larger total yield than vines or draws, while the yield of No. 1's was less—i. e., of the 160 bushels obtained from whole sweetpotatoes 115 bushels were jumbo or "mother potatoes." The source of seed stock, northern or southern, did not influence yields much in the South.

The North Carolina station observed that digging two weeks or longer after a hard killing frost materially increased sweetpotato losses in storage. The best spacing seemed to depend largely upon weather conditions during the growing season; close spacing tended to increase the number of culls, while the wider spacing favored the formation of jumbos.

Tobacco.—The Connecticut tobacco substation grew its 1929 tobacco crop by performing all the cultural operations with a tractor. Plowing and harrowing in open fields presented no problems, whereas shade fields required certain modifications. The 2-bottom plow adopted as suitable for turning the furrow close to and between the poles had a very wide adjustable offset. Certain minor changes facilitated drilling fertilizer, setting plants, and drawing tobacco racks. Cultivating was done with a 2-row cultivator. It was found possible to eliminate packing of the soil entirely by the use of open-face wheels. No great mechanical difficulties appeared to be in the way of entirely replacing horses with tractors in growing tobacco.

Grass.—Under pasture conditions at the Florida station centipede grass produced the best top growth and second best root growth, and Bahia grass had the best root system on Fellowship sandy loam, and these grasses similarly excelled on Norfolk sand under lawn conditions. Bermuda and centipede grasses mowed enough to prevent seed formation produced better developed root systems than when not mowed. Frequent cutting or grazing appeared to be essential for production of more vegetative growth of prostrate-growing pasture grasses even when such grasses were fertilized heavily. Pasture treated with nitrogen yielded about twice as much as that untreated, and its grass contained slightly more protein.

Cutting bluegrass early and often at the Wisconsin station depressed organic root reserves necessary for satisfactory growth in the next year. Heavy fertilizer treatments were a corrective for too close or too early cutting or grazing but might not be economical. Bluegrass for lawns, cut 0.5 inch above the soil surface, was weedier and much sparser and weaker than that cut 1.5 inches above.

The entire grass of reed canary grass on peat soils, the Minnesota station found, ranged on a moisture-free basis from 6.6 to 25.2 per cent in protein content, culms 2.8 to 11.9, leaves 8.5 to 23.5, and panicles from 9.4 to 30.5 per cent. Higher protein content was favored by early mowing, thin strands and an increased supply of available nitrogen. Broadcast seedlings yielded much less hay and protein than row planting. The yield and protein content of hay appeared to be unusually sensitive to the available nitrogen in the soil, and the protein content seemed to be influenced very much by the stage of maturity.

The New Jersey stations made an extensive study of general conditions of turf grasses in New Jersey and their adaptation, fertilizer needs of turf for putting greens, and turf disorders on golf courses. Late summer and early fall proved to be the most favorable time for seeding new lawns and renovating poor ones. Spring seedings must be very early to avoid competition with annual weeds and injury from hot, dry weather. Putting greens on golf courses may be cut as close as three-sixteenths of an inch daily, whereas lawns and fairways need not be mowed oftener than once or twice a week at a height of three-fourths to 1 inch. Different species of grass varied greatly in tolerance to close cutting.

Alfalfa.—The Wisconsin station recommends that alfalfa be cut twice a year rather than oftener, on the basis of the observed relationship between frequent cutting and winterkilling. No important difference between grain varieties as nurse crops for alfalfa was

found. Alfalfa without a nurse crop did not yield more hay the next year than that planted with a nurse crop.

Extensive reduction of alfalfa root reserves in Ohio station studies consistently resulted in a reduction in yield and vigor of growth, and also in severe winterkilling from heaving. The most uniformly important period of root storage at Columbus was in October when the last cutting of the season was early enough to permit considerable top growth by October 1. The best conditions for storage of root reserves seemed to comprise a large amount of healthy leaf area and drier weather than normal.

Leaving the first growth of alfalfa unclipped or clipping not later than the outset of blooming was most favorable for seed production at the Utah station's alfalfa-seed farm. Shallow cultivations sufficient to destroy weeds in early growth without thinning the alfalfa stand had slight influence on seed yields. The highest yields and the best quality of seed were produced without irrigation, and alfalfa in rows or hills yielded more seed than that broadcast. Artificial tripping of the flowers increased the seed yield about 150 per cent.

Clover.—The height of cutting the nurse-crop oats, the Ohio station found, was related to the yields of white sweetclover hay and roots in the fall, and the value in spring for soil improvement was directly proportional to the weight of roots the preceding fall. It was evident that the nurse crop should be cut high.

Studying meadow improvement in the sand-hill region by the use of red and alsike clovers, the Nebraska station found that the best stands and growths of clover were on meadowland lying between 6 and 30 inches above the March water table. Meadows supporting a good sod of bluestem (*Andropogon furcatus*) and Indian grass (*Sorghastrum nutans*) produced good clover, whereas areas showing alkali grasses should be avoided. Alsike is about as drought resistant as red clover, and its longer life and greater winter hardiness make it especially valuable for the subirrigated mixed-hay meadows. Seedings of clovers increased hay yields from 26 to 32 per cent. Broadcast on disked and on plowed meadow, a seed mixture produced 175 and 205 per cent more hay, respectively, than on untilled meadow.

Soybeans.—The development and filling of soybean pods was found by the Missouri station to be the best index for maximum hay yield—i. e., when the pods were well formed and about one-third to one-half filled, at which stage the greatest weight and the maximum protein in the hay as leaves and minimum as woody stalks were harvested. The maximum weight and protein yield were obtained earlier with the crop drilled solid than in cultivated rows.

Grown with corn for silage, soybeans, according to the West Virginia station studies, did not increase the total acre yield over corn alone at the same planting rate, and the yield of shelled corn was reduced by 6 or more bushels. The increase in protein per acre was not enough to compensate for the extra work in growing the combination, and neither crop affected the protein content of the other. Soybeans grown alone yielded practically the same in cultivated rows or sown solid, although those in rows had the higher protein content.

Winter legumes.—Winter legumes made best yields at the Alabama station when drilled about October 1. April 1 harvests showed that woolly-pod vetch, Austrian Winter field peas, monantha vetch, Oregon vetch, and hairy vetch in order produced the most dry material from fall plantings. It was recommended that hairy vetch be turned when the green tops from 100 square feet weigh 12 pounds, and from Austrian Winter field peas and monantha vetch 14 pounds. Drilled winter legumes proving hardy against all low temperatures during six years included the hairy, Hungarian, and woolly-pod vetches, Austrian Winter field peas, and narrow-leaved vetch (southern strain). At the Georgia station nitrogen production by winter legumes was highest in the earliest (September 21) plantings, especially with monantha vetch and crimson clover, increased with the rate of seeding, and was decidedly affected by time of cutting. In general the quantity of nitrogen rose from 50 to 75 per cent from March 10 to 20.

Winter field peas, the Georgia Coastal Plain station found, evidently should be turned under by March 1 for cotton and March 15 for corn. The earliest seedings, October 1 to 15, gave the most green manure at the time of preparing land for corn and cotton. Seeding with the grain drill gave the best yields of green manure, and notable responses resulted from application of potassium, whereas the phosphorus and nitrogen were of doubtful value.

Inoculation.—Subjecting bacteria of both soybeans and red clover in soil to long periods of drying and in soil and cultures to ultra-violet light, the Missouri station observed that when legume bacteria were once well established in a soil through growth and nodule produc-

tion of the host plant they could long remain viable regardless of desiccation and exposure to sunlight. With soils under field conditions longevity extends at least through seven years and probably longer. Evidently when once established in the soil, legume bacteria need not be introduced again as inoculation within periods common to most crop rotations. However, in New York Cornell station studies, supplementing the legume bacteria which the soil naturally supports with artificial culture for alfalfa, red clover, beans, and peas, usually resulted in better inoculation and yields on both limed and unlimed soils.

Many strains of nodule bacteria, found by the Wisconsin station and termed parasitic, did not stimulate plant growth, although forming nodules. Repeated passage of the nodule bacteria from plant to plant seemed to increase the ability of a parasitic strain to fix nitrogen, while the opposite effect was often noted with so-called good strains. The number of nodules on the legume appeared to be related inversely to the nitrogen nutrition of the plant.

Pasture.—Improved pasture, the Delaware station found, could carry one cow per acre compared to one cow to 3 acres, the average capacity of Delaware pastures. Kentucky bluegrass, Canada bluegrass, redtop, timothy, white Dutch clover, and Japan clover composed the best turfs for grazing, whereas other grasses and legumes did not improve pastures or else were detrimental. The highest production was on pasture limed and manured, and the best grazing turf where lime, superphosphate, and potassium chloride were applied. In pastures in southwestern Michigan, largely bluegrass, the Michigan station found that increased yields were favored by proper application of complete fertilizers, plowing, reseeding, moderate grazing, and occasional mowing to control weeds. Carpet grass, Dallis grass, and lespedeza in combination were superior to either sown alone on lowland pasture at the Georgia Coastal Plain station. Carpet grass excelled in establishing sods on moist lowland where native vegetation grows profusely.

The Kansas station showed that perennial herbaceous plants decrease in organic root reserves up to about blooming; thereafter the plants begin to restore the reserves drawn on for top growth. The amount of food reserves in native sod decreased with the frequency and closeness of cutting. The yield of vegetation was indirectly proportional to the frequency of cutting.

In establishing pasture in the mountains for early spring grazing, the Colorado station observed that location, preparation of the soil, seeding, and proper management after planting should receive attention. A pasture mixture for cattle and horses, from two to four weeks earlier than native grasses, included crested wheatgrass, slender wheatgrass, bromegrass, bulbous bluegrass, and yellow sweetclover. A mixture for sheep included bromegrass, bulbous bluegrass, and yellow sweetclover. This station also found that the stand of desirable grasses on sagebrush range increased greatly in the first year after the sagebrush was burned or grubbed out and increased even more in the second year. Natural revegetation by grasses already present rendered artificial reseeding unnecessary. Burning in October was better than grubbing in destroying sagebrush.

CROP NUTRITION

The plant-food requirements of the several field crops and ways to supply them continued to provide a fruitful field of investigation at the experiment stations.

Cereals.—Corn at the North Dakota station matured earlier when stable manure was applied with superphosphate than with stable manure alone. The manure also significantly hastened maturity in several rotations. Clover residues seemed to delay maturity as compared with timothy residues. Limestone applications seemed to hasten maturity slightly, whereas potassium sulphate had a retarding effect. Very heavy applications of either 16 or 46 per cent superphosphate retarded the germination of corn according to Minnesota station studies. With the larger quantities used the time required for plants to emerge was longer. Heavy applications retarded germination less when in intimate contact with the soil for some weeks before planting.

The Iowa station found that early applications of sodium nitrate may increase the yield of oats appreciably and more effectively than late applications. Increased nitrogen content of the grain resulted from either early or late applications. Experiments at the Louisiana station indicated that fertilizers may be of doubtful value for rice. However, they may be best applied to rice in rotation, especially with soybeans. Rice appeared to need plenty of nitrogen and potassium and very little phosphorus, the greatest yield coming from acre applications of 100 pounds each of ammonium sulphate and potassium sulphate. As shown by yields of both grain and straw, fertilizer in the row

with wheat at the Kansas station appeared decidedly superior to that broadcast.

Cotton.—Extensive fertilizer tests by the Arkansas station indicated for the hill section of Arkansas a complete fertilizer carrying ample nitrogen and potassium and being relatively high in phosphorus. A complete fertilizer, as the 4–10–4 formula used, amply supplied with all three elements appeared suitable for the coastal plains area. The lowland soils resembled those of the other types in their response to complete fertilizers. From 400 to 600 pounds of fertilizers per acre appeared suitable for most sections. No soil type, locality, or condition in the State failed to respond satisfactorily to fertilizers for cotton. Working largely with Pima Egyptian cotton in the Salt River Valley, the Arizona station found that profitable returns could not be expected at present from commercial fertilizers on heavy soils.

The Georgia station observed that neither phosphorus nor potassium markedly affected the number of bolls per pound or the lint per 100 bolls, whereas nitrogen and the quantity of fertilizer applied per acre were quite effective, the heaviest rates producing few bolls per pound and more lint per 100 bolls. The Georgia Coastal Plain station found that in complete fertilizer quickly available inorganic carriers of nitrogen, as sodium nitrate or ammonium sulphate, surpassed organic carriers. Potassium as kainite gave better yields than potassium from other sources. From 100 to 125 pounds of sodium nitrate or its equivalent could be applied profitably just before squaring. Both of the Georgia stations have indicated fertilizer formulas and rates for different soil types and conditions.

Fertilizers had no appreciable influence on the length of lint in Texas station experiments both with and without irrigation. All fertilizer treatments increased the percentage of 5-lock bolls, and furthermore the percentage appeared to rise with increase in the quantity of phosphorus in the fertilizer. Heavy applications, as 600 to 800 pounds per acre, resulted in slightly larger bolls than did lighter applications. Complete fertilizers were unprofitable or not beneficial in several localities.

Potatoes and root crops.—Nitrogenous fertilizer applied in the row for potatoes by the Ohio station stimulated rapid early growth, the benefits being most pronounced in early plantings followed by cool weather. The Illinois station observed that the soil should be limed for potatoes only when too acid to grow a legume in the rotation. Rock phosphate was not indicated where heavy applications of manure supply more phosphorus than needed for the crops in the rotation. Barnyard manure gave the most consistent and the largest increases of any fertilizer used.

Sweetpotatoes at the Georgia Coastal Plain station made highest yields in 3-foot rows with plants 16 inches apart and when fertilized with 800 pounds of complete fertilizer per acre. Half the nitrogen in sweetpotato fertilizer evidently should come from an organic, and half from a mineral source. Constant increases in yield resulted from increased quantities of fertilizer.

With Jerusalem artichokes grown by the New Jersey stations on an acid sandy soil, lime increased tuber yields over 100 per cent, and the percentage of the sugar about 10 per cent. Manure did not affect tuber yields but helped increase the sugar content. Fertilizers relatively high in phosphorus and medium in nitrogen and potassium resulted in more sugar per acre than treatments with high percentages of nitrogen and low phosphorus.

Tobacco.—Its extended experiments and experience led the Wisconsin station to recommend for tobacco 1,500 to 2,000 pounds of complete fertilizer per acre on new land not manured; 800 to 1,200 pounds on new land, supplementing coarse manure; and 800 to 1,200 pounds without manure, or 300 to 600 pounds with a light application of manure on productive old tobacco land. Best results from fertilizers also were favored by land free from black root rot or harmful effects of rotation, suitable soils, proper application of the fertilizer, and a practical fertilizer program. Georgia Coastal Plain station experiments suggested at least 1,000 pounds of a complete fertilizer for tobacco, with modifications on the different soils. The potassium salts should be used in such proportion that the chlorine in the fertilizer will be from 2 to 2.5 per cent.

The best returns in fertilizer tests with tobacco by the North Carolina station were had from about 80 pounds of phosphoric acid, ammonia 40 pounds, and potash 60 pounds per acre. Mixed nitrogen gave better results than any individual source, and superphosphate surpassed bone meal or basic slag for phosphorus. Mixture of potassium from two carriers gave better results than all derived from the sulphate or chloride. The yield without injury to burn of cured leaf seemed best when

only 20 to 25 pounds of chlorine per acre were supplied. Magnesia was very beneficial in the control of sand drown and gave decided increases in yield and quality wherever this disorder was evident.

The fire-holding capacity of tobacco from plats denied potash was found by the Connecticut tobacco substation to grow less every year, whereas this quality was not impaired on plats receiving potash. More potash than 200 pounds per acre did not affect the burn or benefit the yield or quality of the crop. The percentage of potash in the leaf appeared to be affected materially by the quantity applied in the fertilizer. The greater the quantity of potash as compared to calcium and magnesium the longer was the burn. There was no indication that tobacco would take up more potash from one carrier than from another. Manure applied annually made the soil less acid, the effect obviously was permanent, and the burn was not impaired.

Of nitrogen compounds supplied Havana tobacco, the Massachusetts station found that the nitrates were the most readily assimilated, and urea, ammonium salts, asparagine, and cystine followed in order. It was evident that cottonseed meal must be ammonified and nitrified before it could be fully assimilated by Havana tobacco. In varying degrees, ammonium salts and certain amino and amide compounds were found toxic to Havana tobacco; nitrate nitrogen tended to counteract the ill effect of ammonium nitrogen.

Meadows and pastures.—The Ohio station cooperating with the Department of Agriculture demonstrated that hay yields in timothy meadows may be increased by using farm manure or by properly selected complete fertilizers. However, fertilization at the current price on meadows for the production of timothy hay worth $12 or less per ton did not appear practical.

Nitrogen as nitrate, ammonium salts, and urea seemed at the Massachusetts station to be assimilated by the common tame grasses. Pasture grasses responded quickly to top-dressings of nitrates, ammonium salts, and urea, and slowly to calcium cyanamide. Rather large quantities of nitrogen did not eliminate white clover from the pasture flora.

From its experiments on pasture typical in topography of much pasture land in West Virginia and too steep for plowing, the West Virginia station recommended that pastures of the type be top-dressed with lime and superphosphate and usually seeded with a simple mixture, and disked or harrowed if not too rough. Top-dressing with manure gives good returns on such pastures.

Lawns.—The lawn experiments of the Ohio station suggested a spring application of 10 or 12 pounds per 1,000 square feet of complete fertilizer, supplemented later with two or more dressings of a nitrogen carrier, depending upon soil fertility. Further benefit might be derived from returning the clippings. The best seed yields of Rhode Island bentgrass were obtained at the Rhode Island station with a fertilizer high in nitrogen.

Applied to creeping bent turf at the New Jersey stations, ammonium sulphate, urea, and sulphur made the soil more acid, whereas liming was the most effective method of correcting acidity. Manure intensified the weed problem because of its weed-seed content. Weeds were reduced on soils made strongly acid and also on soils heavily limed and fertilized with nitrogen; inorganic nitrogen carriers reduced weed growth, irrespective of their effect on soil reaction.

Legumes.—Nitrogen applications exceeding that in 150 pounds per acre of a 2–12–12 fertilizer, the Wisconsin station found, greatly decreased nodule formation in soybeans, cyanamide being somewhat less injurious than other nitrogen forms. Ordinary phosphorus and potassium fertilizers increased nodulation when used in quantities not depressing seed germination. The soil type upon which soybeans grew, in Michigan station studies, was a greater factor in determining the composition of the plants than was the use of moderate quantities of fertilizer.

Fertilization of Spanish peanuts at the Florida station with single elements with and without lime did not return profitable increases in yield on Norfork sand, and liming materially decreased yield. Land plaster profitably increased the yield of most varieties of peanuts where grown on a different area each year but not after the first year or two on peanuts grown continuously on the same area.

CROP SEQUENCE

Many of the stations have considered problems of the cropping system. Where alfalfa or red clover and timothy were each followed by cereals for several years at the New York Cornell station the larger yields of the cereals immediately following the legume declined with the succeeding crops and tended to

become equal to those after the timothy in several years. The legume evidently should be repeated in the rotation often enough to prevent nitrogen from losing its activity at any time. Yields of cereals in two years after an alfalfa or a timothy meadow held for two or three years were not larger than those following a meadow down for one year only.

Legumes maintained yields of continuous corn during 34 years at the Alabama station, whereas without legumes corn yields declined more than half. In a 3-year rotation with legumes, the yields of cotton and corn were four times as great as without legumes. Fertilizers applied in rotations including legumes were much more effective in increasing crop yields than in rotations omitting legumes. Corn after legumes turned under equaled and in some cases exceeded that receiving large quantities of commercial fertilizer.

The Ohio station found it advisable to choose rotations in which destructive insects can be kept at a minimum. This could be done by including in the rotation a crop not susceptible to, or lessening injury by insects that attacked the preceding crop. In its 4-year rotations at Columbus with the hay from different hay crops removed, corn yields after each legume except sweetclover were lower than after timothy. Wheat yielded consistently higher on the legume plats. Where the hay was plowed under, corn always yielded more after legumes, especially alfalfa and sweetclover, than after timothy. Oats yields always were depressed on legume plats by lodging induced by too much nitrogen. Plowing the hay crop under increased the yield of corn materially but usually depressed yields of wheat and oats.

Rice after soybeans at the Louisiana station averaged 500 pounds per acre more than after pasture, and in rotations including cotton, rice averaged highest where soybeans were included in a 3-year rotation and lowest in rotation with fertilized cotton. The residual fertilizer seemed to affect adversely the rice following. Rice yields after soybeans were decidedly higher when only the seed was harvested and much lower after uncultivated, closely drilled soybeans turned under when ripe.

Tobacco.—The rotation corn, hay, and tobacco produced a poorer crop of tobacco at the Massachusetts station than the sequence potatoes, onions, and tobacco, which in turn was not usually comparable to continuous tobacco. Residues turned under in rotations did not so reduce the available nitrogen as to limit the growth of tobacco.

The type of brown root rot present at Poquonock, Conn., was found by the Connecticut tobacco substation cooperating with the Department of Agriculture to be closely associated with the previous crop, becoming most severe in tobacco after timothy, corn, rye, alfalfa, or clover, whereas after potatoes it was less injurious. With continuous tobacco or unfertilized fallowing, injury was reduced to a very low degree, yet leaving the natural weed growth on the land for a year was more beneficial than either practice.

The Wisconsin station observed that in Wisconsin the sod crops, most commonly timothy, are most likely to be injurious to succeeding crops of tobacco, the probability of harm increasing with the age of the sod. If rotation is practiced, brown root rot is likely to result and without rotation black root rot may develop, difficulties to be solved by use of strains resistant to black root rot in continuous culture. Tobacco after tobacco in continuous culture averaged close to the highest yield in the trials.

With tobacco in rotation at the Georgia Coastal Plain station the problem seemed to be principally one of nematode control. Such crops as cotton and sweetpotatoes evidently had no place in a tobacco rotation, and no suitable cover crop was found. About the only crops found safe were corn, small grains, and peanuts harvested and vines removed.

CROP QUALITY

Wheat.—Milling and baking studies at the Nebraska station with standard varieties of Nebraska hard winter wheat showed that protein content is the predominating quality factor, regardless of the environmental conditions. When compared on an equal protein basis Nebraska wheats were in no way inferior to hard winter wheat produced in Kansas or elsewhere.

Data obtained by the North Dakota station in a protein survey with wheat were confirmed closely by tests of more than 30,000 car lots by the Minnesota State Inspection Department. The effect of preceding crops on the protein content of wheat varied considerably in different sections—e. g., in heavy soil areas in eastern North Dakota wheat from alfalfa or sweetclover land usually averaged higher in protein content, in western North Dakota protein content of wheat after cultivated crops and particularly summer fallow tended to increase, and in the Golden Valley County area wheat grown on north slopes averaged higher in protein con-

tent than from south slopes. A cool season favored the production of wheat with a high test weight per bushel. The protein content in barley also was observed to vary with season and variety, such variation evidently being reflected in the feeding value.

The New Mexico station found wheat of the 1928 crop grown under irrigation to average 11.53 per cent in protein and grown on dry farms 14.43 per cent. In general, the protein percentage increased and the yield decreased with the smaller amounts of rainfall. The Montana station demonstrated that Kanred and Marquis wheat subjected to severe weathering conditions were not altered in protein and ash contents, even though marked changes took place in the physical properties and germination. No advantages were obtained either in quality or yield by the Minnesota station by prematurely harvesting rust-infected wheat and oats.

Cotton.—The market value of the lint was lowered in Texas station tests when cotton was ginned with a tight breast-roll, particularly with the longer staples, which sometimes were badly gin cut. The North Carolina station cooperating with the Department of Agriculture demonstrated that cotton fibers from varieties with longer staples were smaller in diameter. There was a general tendency for an increasing length to be associated with a decreasing diameter, and vice versa.

Tobacco.—Analyses of tobacco grown at the New Mexico station indicated that the commercial varieties are not suitable in quality for market demands. The outlook for tobacco as a crop for New Mexico did not seem favorable.

The effect of fertilizers on the quality of tobacco at the North Carolina station and the Connecticut tobacco substation has been noted under crop nutrition (pp. 26, 27). Analyses of Connecticut tobacco from the poor-burning crop of 1924, an extremely dry season, and from the good-burning crop of 1927, a season of high rainfall, showed that chlorine, calcium, magnesium, nitrogen, phosphorus, sulphur, and manganese were higher in the 1924 crop, whereas potash, silica, iron, and alumina were lower. The alkalinity of the 1927 crop was uniformly much higher.

WEEDS

The effective control of weeds has necessitated accurate information on the growth habits and life history of the pest plants and on their reactions to herbicides and to cultivation.

Acid solutions of arsenicals were found by the California station to be more effective than basic solutions in penetrating cortical tissues in the wild morning-glory. Prolonged exposure to the spray solution as by condensation of dew or watering the leaves seemed to increase greatly the depth of penetration of the arsenic. The lethal concentrations of arsenic were 0.02 per cent of the dry weight in tops and 0.0003 per cent in roots.

Canada thistle, mowed by the Ohio station first on June 1, when organic food reserves in the rootstocks usually were lowest, and several times later, was decidedly reduced in stand, and after several years of cutting practically all was gone from areas cut monthly four times, commencing June 1.

The Connecticut Storrs station found that July seemed to be the best time for cutting bushes in pastures so far as subduing undesirable species is concerned, although mowing in August and June was nearly as good.

The Alabama station demonstrated that any cutting treatment reduced the rootstock development of Johnson grass, and the reduction increased with the cutting frequency. Late cutting was as effective as continuous cutting.

For control of marsh cress, a weed bad in oats following corn, especially in low or flat areas, the Iowa station recommended that infested corn stubble be plowed or disked thoroughly before seeding oats. The corn should be kept clean and at the last cultivation sown to soybeans or other legumes. The New Hampshire station observed that broadcasting finely ground kainite may control mustard, another serious weed in oats. Cyanamide was even more effective but tended to cause the oats to lodge. Both materials should be applied when the fields are wet.

Application of lead arsenate to the upper soil layers at from 10 to 100 pounds per 1,000 square feet, the New York Cornell station found, did not prevent germination of weed seeds or the growth of seedlings of a number of common lawn weeds and apparently was not practicable as a general method for weed control.

For land infested with wild oats, French weed, and most other weeds common in the Dickinson district, the North Dakota station found that the most practicable control method adapted to grain farming was duck-foot fallowing. Early tillage appeared essential to cover the seeds so that spring rain would induce germination, and the seedlings would be killed by later cultivation.

A number of stations continued to investigate the merits of chlorates for the control of perennials. For best

results, the Idaho station observed, the areas should not be cultivated just before chlorates are applied, and the underground root system should be represented by adequate top growth. The effectiveness of treatment increased as the plant approached maturity. Areas should not be irrigated following treatment. The Washington station found that a mixture of sodium chlorate with either magnesium chloride or calcium chloride gave very good results, with a reduced fire hazard. The catalase activity of the roots of treated plants appeared to be a good index of the effectiveness of chlorates. Solutions of sodium chlorate, potassium chlorate, and sodium arsenite killed high percentages of quack grass in experiments at the North Dakota station, and intensive hoeing was also very effective. By reburial of the roots and prevention of top growth it appeared that the weed may be eradicated in one season. Two or three sprays of sodium chlorate sufficed to eradicate Johnson grass, in Oklahoma station studies, although a new crop of plants appeared the next season if viable seed were in the soil, and cultivation or another spray was needed to kill the young plants.

The behavior and yields of the crops following chlorate spray, at the Michigan station, showed that late summer and fall applications are not likely to influence production the next season. It did not appear feasible to grow crops during the summer following spring applications, although the residual influence usually is so dissipated by late September that wheat and rye may be sown. Heavy applications of chlorates penetrated the soil much deeper than light applications, yet even the latter could go deep enough to injure shallowly rooted shrubs and trees. From the extensive experience of the Ohio station it seemed safest to count on more or less injury to the crop just after chlorate spraying but none whatever after one year.

HENRY M. STEECE.

HORTICULTURE

Satisfactory progress was recorded in the field of horticultural research during the year, the continued expansion of fundamental work with vegetable crops being the outstanding trend.

Physiological investigations.—A study at the Illinois station upon the transpiration rate of 21 species of deciduous fruits revealed a definite grouping into high, medium, and low rates. The species having a low transpiration rate were those generally accepted by horticulturists as possessing a high degree of drought resistance, and reciprocally those with high transpiration rates had only slight drought-resistant qualities.

No direct relationship between soil-moisture content above the wilting point and the tendency for sweet-cherry fruits to crack was established at the Idaho station; turgor of the cherry fruit was, however, correlated with cracking.

Comparative studies at the New Jersey stations of the Shipper Cling and Elberta peaches, representative, respectively, of the firm and soft canning varieties, showed over 100 per cent more insoluble pectin at the full-ripe stage in the Shipper Cling variety, thus accounting to a large degree for the differences in firmness of the flesh.

The fruit from Elberta peach trees, receiving much and little nitrogen and varying widely in vegetative vigor, differed strikingly in nitrogen content, which was uniformly much higher at all stages in the fruit from the high-nitrogen trees. At no stage was there any significant difference in titratable acidity. A higher percentage of tannin in the green fruits of low-nitrogen trees was practically equalized at the full-ripe stage.

Working upon the color problem in apples, the Maryland station found that application to the soil of sugar in the form of cerelose enhanced to a considerable degree the color of Williams apples. Among several chemicals injected directly into the conducting tissues of the tree, boric acid, hydrochloric acid, cerelose, and sucrose increased color, but the first two had a harmful influence on the tree. Of apples inclosed in red, green, blue, purple, yellow, and transparent cellophane bags, all except those under the red colored normally, it being apparent that the red tissue absorbed the rays that are actively concerned in coloring.

Hardiness studies.—The suggestion developed some years ago by the Iowa station that hardiness of young apple seedlings might be determined by the amount of dye adsorbed by finely ground wood tissue was followed further at the New Hampshire station in connection with the wood of known varieties. It was concluded that the dye-adsorption test is not consistent enough to be utilized as a quick and final test of hardiness in the apple but that it may have value as a supplementary indicator when used with actual freezing determinations. The probability was conceded that other factors

besides hydrophilic colloids are concerned in the hardiness of woody plants, such as the apple.

Using two peach varieties—namely, Salwey and Greensboro, representative, respectively, of groups nonhardy and hardy in the flower bud—the West Virginia station found wide differences in the carbohydrate composition of the buds, those of Greensboro being low in reducing, nonreducing, and total sugars and starch but high in alcohol-soluble nonsugars and hemicellulose. Some evidence was found that the hardiness of fruit buds was reduced by pruning, nitrate fertilization, and partial defoliation, while on the other hand, ringing in June increased hardiness. The production of a large crop apparently reduced bud hardiness to some extent, a condition attributed to the depletion in food reserves. Any treatment which tended to increase the stored food in the bud was considered a measure toward increasing hardiness.

Storage studies.—Working with California-grown grapes, the New York Cornell station found that this fruit kept best at the lowest temperature at which it could be held without actual freezing. For the Emperor variety, 28.4° F. is recommended as a satisfactory storage temperature. In common with other fruits and vegetables, it was found that grapes may be supercooled to a point considerably lower than actual freezing, but this had no practical significance in storage.

Although nitrogen fertilizers were found by the Ohio station to exert a considerable effect on the nitrogen content, moisture content, color, and size of apples, keeping quality was not influenced significantly. In some cases the increase in the nitrogen content of the fruits was well over 100 per cent.

The Maryland station, studying the effects of various nitrogen fertilizers on the firmness and the keeping quality of apples and peaches, found no evidence that any fertilizer had influenced keeping quality, as measured by the pressure tester and actual counts during storage, but there was some indication that cultural treatments that promote oversized fruits may decrease the life of the fruit in storage.

At the Michigan station, Delicious and Wagener apples showing considerable percentage of water core in autumn were found to become entirely normal in appearance following storage for two or three months at 32°. Considering the effect of ethylene gas on the coloration of the McIntosh apple, this station observed some slight influence on the change from green to yellow ground color but none on the red.

Pollination studies.—The importance of pollination investigations in the pomology program of the stations located in the fruit-producing regions was reflected in the number of publications on the subject during the year. Searching for the cause for the frequent failure of self-pollination the Arkansas station concluded that slow growth of the pollen tube in the style of selfed apple flowers is a highly important factor in the failure to set, although varieties were observed to differ quite widely in this respect. In the Stayman Winesap variety there was both a lack and a defectivity of pollen. In all the varieties tested the amount of viable pollen varied between anthers and even between locules of the same anther, whereas ovule development usually was approximately normal and uniform. Abnormalities occurred in all varieties following exposure to unseasonably low temperatures, those temperatures just above freezing apparently inhibiting the fusion of the nuclei and in some cases preventing the development of the fertilized ovules.

The Missouri station found that all apple varieties except those that are outstandingly self-unfruitful, as members of the Winesap group, vary from season to season and in relation to environment in the percentage of self-fruitfulness. Ben Davis, Jonathan, and Delicious proved to be highly effective pollinizers for the other apple varieties studied. In comparing the set of emasculated flowers with those covered but otherwise untreated, no significant difference was found in the set, suggesting that emasculation was not in itself harmful.

Studies at the Minnesota station on the longevity of apple pollen indicated that the moisture of the storage atmosphere is an important factor, since apple pollen remained viable twice as long in a desiccator and three times as long in a vacuum as in the open air of the laboratory.

The New York State station obtained some evidence that the technic employed in emasculating apple flowers may affect the setting of fruit and thus cause otherwise unaccountable differences in the results of experiments. Emasculated flowers without covering set lightly as compared with bagged flowers. That self-unfruitful grapes, even when open-pollinated, do not set so well as self-fruitful varieties was indicated in studies at the same station. Self-unfruitful grapes, even in the pres-

ence of adequate bees, failed to set as well as when hand-pollinated, leading to the view that grape breeders should work toward the development of self-fruitful varieties.

Fruit breeding.—In crosses at the Iowa station between cultivated pears and certain hybrids of cultivated pears and *Pyrus ussuriensis* the progeny showed characteristic differences that could be associated with the better parent; for example, seedlings in which Bartlett figured as one parent were obviously superior to other groups, a fact which supported an earlier conclusion by this and other stations that quality in the seedling is directly dependent on quality in the parents.

Evidence was obtained by the Iowa station that certain apple varieties are more prepotent than others in the transmission of their characteristics, the Ben Davis being cited as an outstanding example.

Thinning investigations.—The need of improving the quality of the product rather than increasing the total production was recognized by the station horticulturists and led to investigations in thinning. At the California station thinning of overloaded olive trees was found highly efficacious in increasing the size of the fruit, and incidentally the returns, since the price of olives depended materially on the size. Thinning olives also tended to promote early maturity and reduced the tendency to alternate bearing. Heavy applications of sodium nitrate, on the other hand, simply increased growth and resulted in a heavy set of small olives and a strong tendency toward biennial production.

Seeking to determine some of the factors underlying thinning of fruit, the Vermont station measured apples at repeated intervals throughout the growing season and found that fruits that are relatively small at the beginning of the season are still inferior in size at harvest; in other words, that the larger apples actually grew more, leading to the inference that the smaller apples might better have been removed early in the season. Definite correlations were established between fruit size and number of seeds, indicating that size is due in part at least to the quality and quantity of fertilization. A close association was also established between leaf area per apple and size of the fruit.

Continuing studies on the berry thinning of grapes, the California station found that thinning the clusters of the Flame Tokay variety resulted in a more uniform development of color, thus facilitating harvesting. Some decrease in the weight of each cluster resulted from thinning, but the size of the individual berries was increased considerably, and it was found possible to maintain the total yields by less severe pruning, which led to more clusters per vine.

Fruit-bud investigations.—Correlating the results of analyses of fruiting and nonfruiting spurs of the Baldwin apple with actual performance of the trees, the New Hampshire station reached the conclusion that insoluble nitrogen is the spur constituent most consistently associated with fruit-bud formation. Conditions which favored the accumulation of insoluble nitrogen were observed to determine in a large measure the actual performance of the spurs. The first indication of flower-bud differentiation in the Baldwin apple was found on August 7, 1928, and on July 19, 1929, a wide discrepancy between the two years being attributed to the results of an extended early summer drought in 1929 which stopped terminal elongation unusually early. Such external factors as the size and the outward appearance of the buds were not found reliable indexes to the time of differentiation. Analyses at repeated intervals of spur samples taken from completely deflorated, half-deflorated, and untreated Oldenburg trees failed to yield definite evidence concerning the factors underlying fruit-bud formation, although the three lots of trees set, respectively, 41.4, 10.3, and 9.2 per cent of fruit buds. The leaf area of the completely deflorated spurs was considerably larger than that of the other two groups.

Cytological examination of apple buds by the Arkansas station showed that Ben Davis and Delicious flower buds are differentiated slightly in advance of other late varieties, Yellow Transparent being the first variety of all to show evidence of flower buds.

Enlarging studies of the fruiting habits of American grape varieties, including the Campbell Early, the Michigan station demonstrated that, unlike the Concord and Moore Early varieties, the larger the diameter of the shoots of Campbell Early, as measured in autumn after harvest, the greater is their producing capacity the subsequent season. This fact held true with all lengths of canes. Campbell Early canes that had 15 nodes outyielded those with more or less nodes, and the variety was most productive on soil too fertile for the Concord grape.

Nutritional studies.—Nutritional problems continued to interest station work-

ers, giving evidence that fundamental knowledge along these lines is still needed.

In laboratory experiments at the California citrus station orange trees growing in galvanized containers in a nutrient medium lacking in boron made poor growth as compared with trees in which the boron requirements were met. Under comparable symptoms in citrus orchards, it is conceded that boron may be a limiting factor to the growth of citrus trees in certain soils.

Studies by the Pennsylvania station in a York Imperial apple orchard, with trees carefully paired on the basis of trunk circumference, height, and spread, failed to show any material difference between sodium nitrate and ammonium sulphate as fertilizers for the apple. Tough bluegrass sods were found to interfere with the beneficial effects of nitrogen fertilizers, apparently utilizing the nitrogen in their own nutrition. The need of shorter rotations of bluegrass is suggested as a means of overcoming this difficulty.

The Arkansas station observed that young Stayman Winesap apple trees growing in fertile soil did not respond significantly to applications of fertilizer, but that decided growth gains were made by fertilized trees in poor soil. No material benefit was noted by the Michigan station from the application of fertilizers to black raspberries growing in fertile soil. From the results of these field fertilizer trials it was apparent that benefits accruing from fertilization undoubtedly are tied up with the inherent fertility of the soil.

Pecan studies.—Various abnormalities in pecan flowers and nuts were observed at the Georgia station in the course of comprehensive studies on this species. Although pecans normally bear catkins laterally on the previous-season wood and pistillate flowers on the current wood, in rare instances both catkins and pistillate flowers arose in a single axis of the current growth. Also some pecan nuts were found to contain one or three cotyledons as a variation from the normal two. However, the rare occurrence of these off types makes them of no economic importance; they serve only to show that the pecan is not entirely stable genetically.

The Florida station in comprehensive studies of the fertilizer needs of the pecan found that nitrogen and potash are the most important limiting nutrients and that it made but little difference as to which nitrogen carrier was used.

Miscellaneous studies.—Attempts by the New York State station to account for the variability in growth and yield within a single variety of apples, even when planted in a single orchard and every possible precaution made to secure uniformity, led to no definite conclusions but did suggest that the soil texture beneath the trees is a factor and indicated that the stocks on which the trees were worked may also be concerned. It was clearly established that variation is not usually a temporary condition but persists throughout the life of the orchard. The reliability of trunk circumference as an index to growth was shown in a correlation coefficient of $+0.972 \pm 0.008$ between the trunk girth and the total weight of the aboveground portion in a total of 21 McIntosh trees.

Michigan station studies on the propagation of the highbush blueberry suggested that the reaction of the soil, temperature, and aeration are important factors concerned in the rooting of blueberry cuttings. Various chemical treatments were tested with no evidence of any conspicuous value in improving rooting. German peat was the most successful of the several rooting media tested.

VEGETABLE STUDIES

Physiological investigations.—Results at the Michigan station were not favorable to ethylene gas as an accelerant in the blanching of celery and in the coloring of tomatoes. In both vegetables, the ethylene-treated product contained less sugar than that handled in the normal manner. The optimum temperature range for the effective blanching of celery with ethylene was found to be very limited and too high for field use in late autumn. Work at the same station on factors concerned in muskmelon quality indicated that quality is determined by the percentage of total solids in the melon, a condition in turn dependent on sugar content. Bright, sunny weather with moderate precipitation favored high sugar content. Any cultural treatment which tended to keep muskmelon plants growing vigorously aided in increasing the quality of the fruit.

Somewhat comparable studies with watermelons at the Alabama station showed quality to be dependent on sugar content, with moisture content inverse to sugar in such a consistent manner that moisture determinations were a reasonably accurate index to sugar content. Fertilizers had no ap-

57146—31——3

preciable effect on sugar content of watermelons, quite as large variations being recorded between the melons of a single treatment as between those of contrasting treatments. In storage at room temperature the sugar content of watermelons decreased rapidly, and even at 35° F. melons could not be kept in good condition for longer than one month.

Chemical changes in peas following harvest were traced by the New York State station, and a rapid decline was revealed in the sucrose after separation from the vine. At the same time the alcohol-insoluble residues increased, presumably at the expense of the sucrose. The practical conclusion is reached that peas should be processed as soon as possible after picking.

In soil-reaction studies at the Kentucky station the highest yields of both tomatoes and lettuce were secured in the pH range 7.5 to 8.5. The use of sodium carbonate to increase alkalinity resulted in markedly greater yields, a result explained in part by the abundance of nitrogen and soluble phosphorus and the moderate quantity of soluble manganese present. The large nitrogen content of soils treated with sodium and calcium compounds is believed to be the result of increased activity of nonsymbiotic nitrogen-fixing bacteria in the presence of an alkaline reaction. The intimate relation of growth and fruitfulness was shown in the fact that production was the greatest at the soil reaction most favorable to growth.

Nutritional studies.—That much is still unknown concerning the nutrition of vegetable crops was evident in the keen interest displayed. Further evidence obtained by the Maryland station on the boron requirements of the tomato plant suggested that certain of the so-called minor nutrients may have much importance in plant nutrition. Within two weeks following the placement of tomatoes in a boron-deficient but otherwise satisfactory culture the plants began to show reduced growth, a condition soon followed by yellowing and death of the tops. An exceedingly small quantity of boron was sufficient to meet requirements.

Studies at the Massachusetts station showed that lime is almost indispensable for onions growing in acid soils. Large applications of superphosphate alone and combined with lime gave evidence that combining the two reduced the lime requirements, but superphosphate alone did not give this result. Onions were grown satisfactorily in a soil with the reaction of pH 6. There was an apparent interrelation between phosphorus and potash, since increasing the phosphorus beyond a certain point without increasing the potash was not beneficial to yield.

At the Arkansas station evidence was found that phosphorus is a highly important ingredient of fertilizers for tomatoes. Nitrogen had some benefit, whereas potash appeared to be of no material value.

At the Ohio station ammonium sulphate was found equal to sodium nitrate as a fertilizer for celery.

Paper-mulch studies.—The possible rôle of paper mulch in vegetable growing continued to receive attention during the year. Aside from the economic aspects, the Ohio station obtained evidence that paper mulch increases the daily mean temperature of the soil as compared with that in tilled plats, whereas soil nitrates varied but slightly between the two areas. Of 31 crops grown at the station 28 yielded under paper mulch as well as, or better than, under tillage.

Vegetable breeding.—The recognized need of improved varieties of vegetables stimulated various studies on this problem. Disease resistance was the object of tomato and cabbage breeding work at the Missouri station and resulted in the development of a strain of Marglobe resistant to Fusarium wilt, designated as Missouri 1001. Copenhagen Market cabbages selected for wilt resistance (*F. conglutinans*) produced satisfactory yields, whereas commercial stocks of the same variety proved total failures. Progress was also made in the selection of disease-resistant strains of other varieties of cabbage.

Some progress was made at the California station in the development of tomatoes possessing resistance to yellows disease and also in determining the genetic composition of tomatoes as concerns the chromosome constitution.

The Pennsylvania station, in again reporting on long-continued tomato-improvement studies, showed that the improvement of any given tomato population can not be continued indefinitely, but when a strain has become established, further selection fails to exert any material influence. The individual tomato plant was conceded to be the unit in selection work. The tomato was found to be essentially self-pollinating; however, a small percentage of natural crossing occurring in the field necessitated the regular roguing of experimental plants.

As a result of breeding continued through five generations a parthenocarpic cucumber named Geneva and

possessing the desirable qualities of its English and American parents was developed at the New York State station.

An interesting fact in connection with cabbage breeding was discovered by the California station. Cabbage flowers self-pollinated while the stigma was yet inclosed in the bud gave much more viable seed than did comparable blooms pollinated at the time flowers were opening and were receptive.

North Dakota continued its activities in vegetable improvement and distributed Golden Gem, a new sweet corn of extremely short growing season.

Lettuce breeding at the Illinois station yielded considerable information concerning Mendelian inheritance in this plant and suggested the probability that cultivated lettuces have been derived from the wild species *Lactuca scariola*.

Miscellaneous studies.—Comparisons at the Ohio station showed glass to be better than glass substitutes as protectors for vegetable plants. In all vegetables except parsley growth was more vigorous, temperature was higher, and more light was transmitted through glass.

At the Arkansas station tomato plants grown with supplemental light made a more vigorous growth, a fact found not due to temperature alone.

A unique hypothesis for explaining the hardening of plants was offered by the Minnesota station as the result of studies with the Early Jersey Wakefield cabbage. Plants exposed to 0° C. for from one to four hours per day gained greatly in hardiness, suggesting that hardening may be the result of shock and not directly correlated with temperature and time exposure.

J. W. Wellington.

PLANT DISEASES

The stations made definite progress during the year along a number of lines in plant pathology, but especially in breeding for disease resistance, in studies of the nature and control of virus diseases, and in the use of sprays and other means of controlling plant diseases.

Disease resistance.—Studies in the development of strains of plants resistant to various destructive organisms continued to be productive of results.

In its cabbage-breeding work the Wisconsin station found that resistance of the cabbage plant to yellows disease is controlled by a single Mendelian factor. The yellows disease apparently entered susceptable cabbage plants at the extreme root tips and occasionally entered resistant plants without progressing to the water vessels. Several highly resistant lines of cabbage were developed for the industry.

The Wisconsin station also determined that resistance of canning peas to Fusarium wilt is based on a single factor with no linkage between resistance and sugar but with a loose linkage of approximately 31 per cent between resistance and tallness. The possibility of developing commercially desirable varieties of peas with high resistance was considered promising.

The Invincible tomato, developed by the Virginia truck station from a cross between Marvel and Bonny Best, proved of merit on account of resistance to wilt and productivity.

Virus diseases.—In studies conducted on Long Island, the New York State station found that cabbages were either highly resistant or immune to the mosaic disease of crucifers that occurs commonly on rutabagas. Brussels sprouts and cauliflower were susceptible to infection but only in a moderate degree. The conclusion was reached that cruciferous mosaic will not likely become a serious factor in cabbage, cauliflower, and Brussels sprouts production on Long Island because of the natural resistance of these species, and also because they are grown usually in the cooler part of the year.

The Ohio station ascertained that aster yellows, caused by a virus carried from certain weeds by a leaf hopper, may be controlled fairly well by surrounding the aster plants with a fine-meshed wire fence which excludes the insect carriers.

Studies by the Wisconsin station of the virus infections of the potato indicated that all apparently healthy plants carried a virus, which is a mild or attenuated form of the more serious rugose mosaic. Four species of aphids were found to carry cucumber mosaic from diseased to healthy tobacco plants. The peach aphid retained cucumber mosaic for only a short period, but long enough to insure the transmission of this disease. The symptoms resulting from the transfer of cucumber mosaic to spinach suggested a possible relationship between the cucumber mosaic and the ordinary spinach blight.

Attempts by the Georgia station to transfer peach rosette by inoculation with organisms isolated from diseased branches gave negative results.

Physicochemical studies at the Indiana station of viruses showed no development of streak disease in tomato plants inoculated with a combination

of juice from potato tubers and a noninfectious filtrate from diseased plants, which produced fernleaf symptoms. Tomatoes developed streak when inoculated with residues containing the tomato-mosaic principle and juices from potato tubers. The inoculation of tomatoes with the filtrate freed from the infectious-mosaic principle produced the fernleaf symptoms. Tomatoes which showed the fernleaf symptoms as a result of inoculation with the noninfectious filtrate in some cases outgrew these effects.

The leaves of mosaic-infected bean plants had, in most cases studied at the Idaho station, a curled or distorted appearence with patches of lighter green interspersed amid the normal color. There was evidence of varietal differences in susceptibility. The occurrence of more insects in the diseased than in the healthy fields was considered significant. Low temperatures prolonged the incubation period and reduced infection in artificially inoculated plants. Planting resistant strains and consistent roguing were suggested as the most promising means of controlling bean mosaic.

Using a Todd U-tube electrophoresis apparatus and a plant extract containing tobacco-mosaic virus, the California station observed a response very similar to that of bacteria and chemically inert particles, except that the virus did not migrate to the cathode at pH values below 3.

Sprays and spraying.—The potential function of dusts as substitutes for the heavier and more cumbersome liquids in the spray program interested several of the stations. Sulphur dry lime-sulphur dust checked apple scab nearly as effectively at the Ohio station as did liquids, but for cherry leaf spot the liquid lime-sulphur, 1–40 or 1–50, furnished the most effective control, although it was conceded that in seasons of mild infection dusts may give satisfactory results. The toxic factor in sulphur was found to be pentathionic acid, an oxidation product. Hydrated lime of good grade was found to equal stone lime in the manufacture of Bordeaux mixture. High-calcium lime gave somewhat better results than did high-magnesium lime.

In greenhouse studies in which the environment was under some measure of control, the Wisconsin station obtained very good success with lime-sulphur 1–40 plus arsenate of lead 1–50 for the control of apple scab when applied 35 hours after the beginning of an infection. Sulphur dusts and wettable sulphur were much less effective than lime-sulphur in checking scab after infection had actually occurred. Calcium arsenate and lead arsenate when used alone had little controlling effect on scab, yet the addition of lead arsenate increased the effectiveness of either lime-sulphur or calcium sulphide. Neutral soap added to wettable sulphur increased its fungicidal value, and the soap alone reduced scab about one-half.

A method of sieving sulphur developed by the New York State station was accurate for sieves as fine as No. 325 of the Bureau of Standards series and was deemed of great importance in eliminating inferior grades of dusting sulphur, the efficacy of which is said to depend primarily on the size of the particles, those above 27μ probably not adhering to foliage.

The Ohio station found that mixtures of lime-sulphur and lead arsenate in summer-spraying strength contained a dangerous amount of water-soluble arsenic and that the more dilute the lime-sulphur was up to at least 1–100 the greater was the amount of this soluble material. Freshly made high-calcium hydrated lime was the most effective corrective for the water-soluble arsenic. Various factors, such as temperature, period of drying, type of water, and the nature of the corrective agent, played a rôle in the production of water-soluble arsenic in lime sulphur-lead arsenate mixtures and were believed to explain in part the spasmodic occurrence of spray injury.

Seed treatments.—Treatment of cotton-seed with various disinfectants failed to show any benefit at the Georgia station in the control of the root disease caused by *Fusarium moniliforme*, although in some instances it increased germination.

Mercuric chloride gave the best results of various materials tested by the Washington station for the treatment of Rhizoctonia-infected seed potatoes. The treatment of pea seed with disinfectants apparently stimulated the growth of the plant, but the treated plants, because of their luxuriant growth, suffered more from later droughts than the controls.

Application of organic mercury disinfectants with the fertilizer was found by the New Jersey stations to be an effective means of combating scab of potatoes, a higher percentage of scab-free tubers being gained than from direct seed treatment. Acidulated mercuric chloride was found beneficial in the treatment of the hard-rot disease of the gladiolus, an immersion for 15 minutes in mercuric chloride at 50° C., with or without acid, giving effective results. For the control of scurf on

sweetpotatoes, the New Jersey stations found mercuric chloride to be the most effective, although the organic mercury compounds caused less sprout injury and were easier to use.

The Idaho station observed that formalin was as effective as any of the organic mercury compounds for the control of covered smut of oats, and that copper carbonate dust was the best disinfectant for seed oats for the control of stinking smut.

From tests of many disinfectants for the control of sweetpotato scurf, the North Carolina station developed a successful treatment in which sulphur was dusted on plants and roots just prior to setting in the field, thereby creating an acid environment which effectively prevented a further spread of the fungus. A 10 per cent hydroxymercurichlorophenol with 90 per cent inert material also proved effective in scurf control.

Greenhouse troubles.—Injury to greenhouse plants sprayed with Bordeaux mixture and later subjected to cyanide fumigation, the New Hampshire station found, was apparently associated with the formation of cupric cyanide, which decomposes with the liberation of cyanogen.

None of 30 chemicals tested at the Ohio station for the control of nematodes in greenhouse soils were found so satisfactory as steam sterilization, which destroyed not only the nematodes but also Fusarium wilt and other soil-harbored pathogenes.

The value of proper management of the greenhouse in the suppression of disease was shown by the Massachusetts station, where a 70 per cent reduction in tomato leaf mold and an 18 per cent increase in yield resulted from simply applying good managemental practices in relation to ventilation and otherwise.

J. W. Wellington.

ECONOMIC ENTOMOLOGY

Investigations in entomology reported by the stations during the year dealt with a wide range of fruit, vegetable, field crop, greenhouse, and other insect pests, as well as with apiculture and with insecticides and other means of control. Some of the more significant results of these investigations are noted below.

FRUIT INSECTS

Codling moth.—The control of the codling moth continued to be a leading problem under investigation, due in large part to the necessity for eliminating arsenical residues from the fruit. The work of the Illinois station indicated that certain oil sprays, or oils combined with other insecticides, are fully as effective as lead arsenate in late sprays but that they can not be used throughout the year. In a comparison made at the Idaho station of lead arsenate alone and in combination with oil the combination produced 15 per cent more sound apples on a 2-year average than did lead arsenate alone. Oil alone proved ineffective in codling-moth control, while an oil-nicotine combination following early cover sprays of lead arsenate produced a high degree of control with a low residue. At the Washington station, nicotine-oil combinations proved as effective as lead arsenate when applied as a cover spray for the first brood and was decidedly more effective when applied as a second-brood spray. The New Jersey stations found that either white oil pyrethrum or nicotine tannate can be employed for the destruction of the codling moth with as high a measure of control as can the arsenical sprays. It was also observed that pineole soluble, diluted with equal parts of water and properly applied, would destroy approximately 100 per cent of the hibernating codling-moth larvae.

Geraniol added by the New Mexico station to some of the codling-moth baits increased the catches, whereas β naphthol-engine oil treatment applied to either corrugated or burlap bands was superior in its killing effect on the larvae to all the other materials tested, from 60 to 90 per cent being destroyed. Paradichlorbenzene at the rate of 6 ounces about the trunk of each tree and calcium cyanide at the rate of 8 ounces caused a mortality of 88.8 per cent, while carbon disulphide at the rate of 12 ounces per tree caused a mortality of 92 per cent. A commercially prepared β-naphthol band was found by the Pennsylvania station to destroy all larvae that had been in the bands for two weeks. Observations made in apple orchards by the New Hampshire station in 1929 indicate that the number of codling moths caught in alcoholic traps in the spring determines the advisability of using a cover spray for its control. When 10 or more moths were caught at the same time the spray was found to be worth while. The Indiana station found that 97 per cent of the cocooning larvae of the codling moth would be destroyed by various banding materials and chemicals.

Oriental fruit moth.—The oriental fruit moth in its injury to the peach equals if not surpasses that of the codling moth

to the apple. It also is an important enemy of the apple and quince. The Virginia station found that while the moths of this pest were attracted to peaches in midsummer in much larger numbers than to apples, this condition was reversed in the fall with the result that moths may migrate to the apple orchard from the peach orchard. It was discovered that the time of picking Elberta peaches with relation to the leaving of the fruit by third-brood larvae may influence the number of moths of the third brood which migrate to apples. Apples in peach orchards that lacked varieties of peaches ripening later than Elbertas were found to be an important source of wintering larvae. The observation by the Pennsylvania station that some Elberta peaches had less than a 5 per cent injury by the oriental fruit moth at picking time whereas others showed 25 per cent or more, was considered to have been related to the nature of the soil and thoroughness of cultivation. The Delaware station observed that much of the damage to late apples was due to the oriental fruit moth, which, after the peach crop had been picked, centered its attack on apples.

Biological control of the oriental fruit moth involving the attact of minute wasplike parasites, of which *Macrocentrus ancylivora* is the most important, has been given increasing attention in recent years. Experiments in 1928 and 1929 at the New Jersey stations, where the work has long been under way, showed that larval parasitism by *M. ancylivora* could be increased in young orchards in the northern part of the State by the liberation of this parasite during June, July, and August. The New York State station succeeded in establishing this same parasite in areas of new infestation, e.g., twig collections in 1929 from the Hudson Valley and from Long Island showed a parasitism of 51 and 89 per cent, respectively. Of 30 parasites of the oriental fruit moth known to occur in Connecticut and neighboring States *M. ancylivora* was found by the Connecticut State station to be the most important enemy of the larva. From 80 to 100 per cent parasitism was observed in August or later in an orchard where liberations had been made of material received from New Jersey. The Connecticut State station also found the common egg parasite *Trichogramma minutum*, to be an important enemy of the oriental fruit moth; it was observed to parasitize as high as 80 per cent of the eggs by September 6 in an orchard at New Haven.

Other apple insects.—Where lights in the apple orchard were used as attractants for the bud moth by the New York State station, the injury to leaf clusters was from 8 to 26 per cent less in the lighted parts of the orchard, and from two to seven times more bud moths were present. This station found that in heavily infested orchards nicotine was the only material used to which the overwintering larvae were noticeably susceptible. In control work with the fruit-tree leaf roller, the Wisconsin station obtained best results when infested trees were sprayed early in the season when the buds were swelling but before much green growth of leaves appeared, with a homemade cold-mixed oil emulsion using oil at 8 per cent strength. This spray when thoroughly applied killed 95 per cent of the eggs before they could hatch. The larvae of the giant root borer of apples were found in the roots of oak trees by the South Carolina station, which warned against planting young trees in newly cleared land, especially where oak had been growing. In combating the green apple aphid the New Jersey stations obtained a satisfactory kill through the thorough application of a spray consisting of one-third pint of 40 per cent free nicotine and 6 pounds of potassium oleate soap (40 per cent water) to 100 gallons of water.

Lime-sulphur containing nicotine sulphate was found by the New York State station to give superior results in combating the rosy apple aphid and to be the preferred spray mixture. Dry lime-sulphur and liquid lime-sulphur were found by the Connecticut State station to be equally effective as apple sprays, but the fruit from the trees dusted with dry lime-sulphur had a better finish. The sulphocide-scalecide treatment resulted in a higher percentage of good fruit in three of four varieties involved in the tests. The oil-sprayed leaves of both Wealthy and Gravenstein varieties were found by the New Jersey stations to contain more chlorophyll than did the corresponding checks. In combating the European red mite the heavy oils were found by the Connecticut State station to be more effective than light oils emulsified according to the same formula.

The pear psylla.—All lubricating oils in cold-mix emulsions and the various commercial oil preparations tested by the New York State station proved effective in reducing the number of adult pear psylla and in rendering trees congenial to them. The danger from using oil sprays for more than two successive

seasons without recourse to nicotine sprays for a season or two was emphasized.

Citrus aphids.—The Florida station found that if the mean temperature is above 60° F. in January, citrus aphid outbreaks are apt to occur the following spring, although they may be prevented by a severe freeze which cuts off their food supply or by heavy dashing rains. The thorough clean-up of the young aphids on trees during the winter, particularly during January, combined with the stimulation of spring growth by cultivation and fertilization, was found to be effective in preventing an outbreak. Spreaders, including an oil derivative and various oleates, that will reduce the cost of nicotine sprays and aphicides by half, were discovered during the year. A spray of lime-sulphur and two sprays of oil emulsion, one in May and one in July, applied by the Texas station resulted in securing grapefruit commercially free of scale insects and rust-mite damage.

Cherry and blueberry pests.—Working with cranberry and blueberry pests the New Jersey stations found that at a temperature of 70° F. or above, soil mixed with flake naphthalene at the rate of 3,000 to 1 was deadly to wireworms. Pyrethrol was the first material found to kill wireworms, after they had begun their attack, without damaging the plants.

VEGETABLE INSECTS

Mexican bean beetle.—The Mexican bean beetle, now widespread through the eastern United States, continued to call for investigation at several of the stations. The South Carolina station found that under the weather conditions prevailing in 1929 magnesium arsenate was the only arsenical effective in controlling the pest and harmless to the plant. Spraying was more than twice as effective as dusting for this beetle in experiments at the Georgia station.

Other vegetable insects.—The bean jassid was effectively controlled by the Florida station with a pyrethrum compound applied as a spray. Liquid sprays appear to be more effective than dusts in the control of this insect.

Carrot rust fly injury to potted carrot plants was reduced 35 per cent, by the Massachusetts station, by dusting the soil and seed with calomel.

Oviposition by the pepper maggot fly in the fruit was materially reduced at the New Jersey stations by dusting the plants with talc.

The onion maggot which, it is stated, often destroys 50 per cent or more of the onion crop in the large producing sections of Cook County was controlled on a commercial scale, by the Illinois station, by the use of a 2 per cent boiled lubricating-oil emulsion in Bordeaux mixture. The New York State station also found the lubricating-oil emulsion to be an effective and economical treatment for this insect.

The harlequin bug was effectively controlled by the North Carolina station by the use of a 2 per cent soap solution applied on very humid days or early in the morning when the dew was on the plants.

Insect pests of melons and related crops were effectively controlled by the Missouri station, with little injury to the crops, with a dust mixture consisting of 1 pound of calcium arsenate and 15 pounds of gypsum applied regularly from the time the plants came up until they began to vine and blossom.

Wireworms were killed by the New Jersey stations with a mixture of pyrethrum extract and soap without injuring the vegetables on which they were feeding.

FIELD CROP INSECTS

The affection known locally as "pouts," which occurs in the peanut section of North Carolina, and in its general aspects resembles the tipburn of potatoes, was found by the North Carolina station to be caused by leaf hoppers of several species. The Kentucky station, in continued studies, discovered that a single adult or nymph of the leaf hopper *Empoasca fabae* might cause the death of young clover and alfalfa plants. The velvetbean caterpillar, which appeared in the Everglades in destructive numbers on peanuts, on which it was observed for the first time to lay its eggs, was found by the Florida station to be controlled satisfactorily by the application of calcium fluosilicate. It was found by the Louisiana station to show decided preference for soybean varieties and velvetbean but was controlled by use of calcium arsenate dust containing 5 per cent hydrated lime. Sodium fluosilicate of the light dust type, without hydrated lime, also gave good control with very little burning when applied to dry foliage. Both calcium arsenate and lead arsenate, which kill the caterpillars, injured or killed soybean plants.

Sodium fluosilicate diluted with hydrated lime in the proportion of one to three at the Alabama station was the most satisfactory material for combating the southern corn root borer. It

was observed that the adults may obtain a lethal dose of poison by using their mandibles to clean off the dust picked up by the tarsi while crawling over the dust-covered surface of a plant. In laboratory tests by the Pennsylvania station, with large numbers of eggs of the European corn borer, technical white oil at 1 per cent strength in a kaolin-oil emulsion and in two proprietary emulsions gave from 92 to 97 per cent control of eggs. A 0.5 per cent oil with 4 pounds of acid lead arsenate to 100 gallons gave a reduction in larval establishment of over 90 per cent.

The Hessian-fly population of any one locality, according to the Kansas station, consists of a mixture of two or more genetically distinct strains which differ in their ability to infest various wheat varieties. Florida station experiments extending over three years led to the conclusion that calcium arsenate diluted with hydrated lime, well mixed and distributed, controlled the cotton boll weevil as well as did the undiluted material. Three applications of calcium arsenate dust at the rate of 5 pounds per acre at 5-day intervals gave good control at the Beeville, Tex., substation and permitted the production of one-half bale of cotton per acre as compared with one-fourth bale on nearby unpoisoned fields.

Dusting with 300-mesh sulphur for the control of the tarnished plant bug, cotton flea hopper, and other insects causing similar damage, by the Mississippi station, resulted in an average increase of 275 pounds of seed cotton per acre. Application of the dust at 10-day intervals apparently was as effective as at 5-day intervals. For control of slugs in tobacco beds, the Wisconsin station found that an 8 per cent nicotine-Bordeaux dust, consisting of magnesium limestone, 35 per cent, monohydrated copper sulphate 20, hydrated lime 20, and nicotine sulphate 10 per cent, gave better results than the hydrated lime alone and was superior to all other insecticides tested.

GREENHOUSE AND OTHER INSECTS

The greenhouse leaf tier was controlled successfully at the Illinois station by dusting the underside of the leaves with a mixture of 85 per cent sulphur and 15 per cent arsenate of lead. Trapping the moths by the use of white lights was found to assist in the control, 200-watt white lights being much more attractive than red, blue, or green lights. The Kentucky station controlled the greenhouse white fly more effectively by a pyrethrum spray, applied before noon on a sunny day with a house temperature of about 100° F., than by treatment with nicotine or hydrocyanic acid gas. The placing of about one-sixth of an ounce of paradichlorobenzene, or a ball of the material as large as an ordinary moth ball, in the cyclamen flats when the plants were first set out was found by the Illinois station to clean almost completely even heavily infested plants of mites. Plants treated in this way came through the season with normal foliage and produced a heavy bloom. The Pennsylvania station found a new pyrethrum dust (60 per cent active) to be a cheap and effective insecticide for the mushroom fly.

Marked differences in the reaction of mosquitoes to different chemicals at the New Jersey stations led to the separation of the chemicals into two general groups, one bringing about violent activation and the other acting as a drug. The New Jersey stations observed that crank-case waste oil, when properly strained and mixed with a cheap toxic spreader such as cresylic acid, Varnolene residue, or kerosene, produces a heavy killing film against mosquito larvae and pupae. Such an oil mixture, when sprayed on the surface of the mosquito-breeding water lasts from two to four weeks or twice as long as the ordinary fuel oil, and the cost is approximately half that of fuel oil.

Eggs of the *Anopheles vexans* mosquito collected by the Montana station in 1928 and stored in sealed glass vials in a refrigerator hatched readily in 1930 when subjected to a higher temperature. Eggs of this mosquito, allowed to dry out until shriveled, hatched on being placed in water. Exposure to a subzero temperature for long periods had no apparent detrimental effect.

In experiments with ox warble flies, the Virginia station found that benzol, 90 to 100 per cent, injected into larval cysts effected a high percentage of kill. Hand extraction at intervals of 30 days repeated five times was a practical and effective method of control. Used against the leopard moth the combination of any one of several insecticides, including naphthalene, nicotine, and benzyl chloride, with pineol soluble was found by the New Jersey stations to be effective against deeply imbedded larvae as well as shallowly imbedded larvae.

APICULTURE

The tar-paper pack without special ventilation was found by the Wyoming station to give the best results when measured by the weight of bees surviving in the spring. The Wisconsin

station found that the optimum temperature for storage of honey was below 50° F., and that honey stored for a year at 32° showed virtually no change in flavor or color. The results indicated that honey should never be held in warehouses or other storage places where temperatures are allowed to exceed 80°, since its color rapidly darkens at such high temperatures.

INSECTICIDES

The required strength of nicotine toxic to aphids, the New Jersey stations found, was reduced greatly when 0.5 per cent sodium oleate was added to the spray mixture. The apple aphid and *Aphis sorbi* were controlled by 6 pounds of commercial oleate to which one-third of a pint of Blackleaf 50 was added per 100 gallons. Attempting to increase the effectiveness of the nicotine insecticidal unit charge, the New Jersey stations found that sodium-oleate soap, soap unit for soap unit, is more effective in reducing interfacial and surface tensions than fish-oil soap, and that either is more effective for this purpose than any other substances tested.

Further experiments with fluorine compounds led the Tennessee station to the conclusion that cryolite, which is a fluoride of aluminum and sodium and barium fluosilicate offer the most promise at the present time as arsenical substitutes. For adult insects barium fluosilicate is more toxic than cryolite, although both materials gave excellent control of the Mexican bean beetle when used as a spray at the rate of 1 pound to 50 gallons of water. Fish oil was found to improve materially the sticking qualities of both compounds.

Caterpillars transferred to apple trees sprayed 1 hour previously with an alcoholic suspension of pyrethrum flowers died within 24 hours, in experiments by the New Jersey stations, whereas they suffered no ill effect when transferred to the same trees five hours later.

In tests of 18 orchard sprayers with tanks ranging from 200 to 465 gallons, the California station found the speed of the agitator to be the most important factor in efficient agitation in the use of oil sprays.

Paradichlorobenzene and carbon disulphide used at rates of 20 and 15 pounds, respectively, per 1,000 cubic feet of space were found by the Louisiana station to be equally effective in fumigating grain to kill weevils. However, corn fumigated with paradichlorobenzene imparted an objectionable flavor to eggs and milk from animals to which it was fed.

WILLIAM A. HOOKER.

ANIMAL PRODUCTION

Recent reports of station work in animal production show continued progress in the study of basic problems of nutrition, as well as of questions more immediately concerned with the practical feeding and management of livestock. A scientific foundation is thus being laid for practical methods.

Nutrition.—The vitamin contents of many different feeds are still in the process of determination. Biological analyses at the Indiana station indicated that the relative vitamin A content of a hybrid yellow corn containing about one-third as much yellow-color character as yellow corn was closely related to the amount of yellow pigment present. Yellow dent corn was found by the New Jersey stations to be a more potent source of vitamin A than a white-capped yellow dent variety. At the Arizona station yellow milo proved to be twice as potent in vitamin A as hegari, and yellow corn contained approximately 20 times as much vitamin A as hegari.

The Texas station showed that yellow corn contained one unit of vitamin A in from 0.15 to 0.35 gram, white corn less than one unit in 18 grams, strawberry corn one unit in from 0.7 to 1 gram, and dried sweetpotatoes one unit in about 0.4 gram. The vitamin A content of yellow corn was practically the same as that of alfalfa leaf meal and greater than that of orange peel and pulp. The wheat kernel was found to be richer in vitamin B than in vitamin G, in studies at the Ohio station, and corn and oats contained about the same amount of vitamin B as wheat. When the vitamin B content of yeast is used as a standard of 100, the vitamin B content of wheat is considered to be 10. The Missouri station found indications that vitamin B is a mixture of an antineuritic factor and of a factor not clearly understood but essential for maintaining life.

Somewhat more practical in nature were studies at the New York Cornell station in which it was found that some destruction of the vitamin D in cod-liver oil occurred in mash mixtures during storage at room temperature in burlap bags. The amount of vitamin D destroyed varied directly with the length of the storage period. The New Jersey stations found that alfalfa leaves from plants dried by artificial heat con-

tained about seven times as much vitamin A as the leaves of field-cured plants from which most of the green color was lost. Little vitamin D was found in the leaves of the artificially cured plants, whereas in sun-cured alfalfa there was an increase in the vitamin D content of the leaves. However, the increase in vitamin D was gained at the expense of the vitamin A content.

The value of different minerals in the animal body is not yet clearly understood, and while experiments have produced significant and instructive results, much work remains to be done on this subject. Some of the beneficial effects of iodine feeding under certain conditions already have been rather definitely established, but further work is in progress with this element in an effort to learn more clearly its possibilities. Tests at the Illinois station showed no significant difference in the rate of growth of pairs of pigs, one of which received the equivalent of 1 grain of elemental iodine daily. Nor was there any evidence to show that the utilization of either nitrogen, calcium, or phosphorus was favorably affected when potassium iodide was fed, although indications were that the retention of calcium was adversely affected. Iodine feeding in conjunction with desiccated thyroid at the West Virginia station greatly speeded up metabolism, the thyroid acting as an accentuator of food deficiencies. Calves fed iodized milk at the Ohio station grew more rapidly and were in better physical condition than calves fed normal milk.

Rock phosphate, due to its fluorine content, was found by the New York Cornell station to have a deleterious effect upon the growth and bone formation. The blood of pigs receiving ferric citrate at the Illinois station showed a significantly higher red-cell count and higher iron content than the blood of pigs receiving no iron. The feeding of excessive quantities of magnesium salts at the Wisconsin station reduced the palatability of the ration, lowered the feed intake, and was accompanied by severe digestive disturbances. Smaller quantities did not result in the above disturbances, although magnesium fed in the form of either chloride or carbonate had no effect on the calcium assimilation of diets deficient in, or supplemented with, adequate calcium. Magnesium salts also had no effect upon the severity of rickets developed on a high-calcium, low-phosphorus diet. It appeared that the digestive tract has a selective absorptive capacity for magnesium.

The addition of iron and copper salts did not increase the hemoglobin content of the blood nor the iron and copper content of the livers of chicks, in Wisconsin station studies. Leg weakness of chicks appeared earlier, at the New Jersey stations, when a rachitic diet low in calcium but high in phosphorus was fed than when a similar ration low in phosphorus and high in calcium was fed. The blood serum of chicks on a ration in which the calcium exceeded the phosphorus contained more calcium than inorganic phosphorus, whereas, when the ratio of calcium to phosphorus in the ration was reversed, the inorganic phosphorus of the blood serum was higher than the calcium. Tricalcium phosphate fed alone or with calcium sulphate or calcium carbonate caused increased growth and leg-bone development of chicks at the Kentucky station, yet had no significant effect on the ash content of the bone or on the percentage of calcium and phosphorus in the ash.

The ratio of calcium to phosphorus, within certain limits of concentration, was found by the Ohio station to be of more importance for normal growth and calcification than the quantities of these elements present. Phosphorus was found to be as much of a limiting factor as calcium in the growth and bone development of the chick. The New Jersey stations observed that during egg production usually more phosphorus was excreted than during nonproduction, and more than necessary to form tricalcium phosphate with the excretory calcium. These observations indicated a metabolic change involving phosphorus compounds during egg formation. Duing nonproduction the percentage of phosphorus retained exceeded that of calcium, and the phosphorus in the excreta was less than required to form tricalcium phosphate. The ratio of calcium to phosphorus in the droppings was lower during egg production than during the nonlaying period.

Breeding.—There is evidence of increasing interest on the part of station investigators in the factors concerned with the reproductive cycle of farm animals. Recent developments have shown quite conclusively that the cyclic changes in the organs associated with reproduction are controlled largely by hormones secreted by the ovary itself and by other glands. Particular attention has been given to the function of the hormone of the anterior lobe of the pituitary body, a ductless gland located between the brain and the roof of the mouth. This hormone, according to investigations by the California and

Missouri stations, stimulates the reproductive processes through direct action on the ovary, resulting in the production of ova by immature females, and the anterior lobe of the pituitary taken from either male or female animals is potent in this respect.

Beef cattle.—Growth studies with beef cattle furnished information of value during the past year. The Missouri station found that the length of the growth period of normal beef steers was about 6 years but may be prolonged to as much as 9 years by a low plane of nutrition. Severe undernutrition during the first 3 years or longer tended to reduce the mature size, which was affected by the severity and length of underfeeding. Retarding the growth did not result in abnormalities in form.

In studies of the growth of range cattle ranging in age from birth to 30 months, the Texas station found that the animals increased rapidly in body weight from mid-April to mid-July, slowed down in weight increase from late summer to early winter, and lost weight from mid-January to early March. The variations in weight increase were related directly to variations in weather and pasture conditions. Body measurements which were affected by the degree of fatness increased rapidly from March to September, and slowly from September to March, and the same was true of measurements of body circumference. Head measurements and the length of long bones increased at about a normal rate regardless of the variations in weather and pasture conditions, while measurements of other body parts for skeletal growth were intermediate. Indications were that growth was retarded in parts of the body during periods of scanty feed, although there was no evidence of permanent stunting.

Adding ground limestone to a ration with alfalfa hay as the sole roughage at the Kansas station did not decrease the cost of gains or increase the rate of gains, but when the roughage was prairie hay, addition of ground limestone increased the rate of gain and the finish attained without affecting the cost. Even with the addition of ground limestone, prairie hay was not so valuable as alfalfa hay. Decided advantages came from adding ground limestone to a roughage ration of silage and alfalfa hay or of silage and prairie hay.

When the Illinois station fed steers a ration of ground corn, cut alfalfa, linseed meal, and molasses at different levels, starting at a very high level and gradually decreasing, the digestibility of the dry matter, nitrogen-free extract, and ether extract rose with each decrease in the quantity of feed provided, while the digestibility of the protein and crude fiber varied irregularly. Heat production declined with each decrease in feed, representing a lessened wastage of feed energy as animal heat. The available energy increased with each decrease in feed, because of the enhanced digestibility of the nutrients.

To determine whether a ration composed largely of cottonseed meal was deficient in vitamin A, the North Carolina station fed a ration of cottonseed meal, cottonseed hulls, beet pulp, and minerals to five steers. For about 110 days all the animals appeared to be healthy and vigorous and made good gains in body weight; but in the next month they lost weight, and by the end of 200 days two animals had died and two others were swollen and emaciated. Post-mortem examination of the dead animals showed an extremely edematous condition, particularly around the joints and in the flank and brisket regions.

At the Minnesota station sweetclover hay almost equaled alfalfa hay in winter rations for stocker cattle and produced considerably more gains than wild-oat hay. Aged steers were fairly well finished on a ration of barley and sweetclover hay, although alfalfa hay was more palatable, and under similar conditions cattle consumed more of it and made larger gains than those on sweetclover hay.

From its study on the characteristics of crossbred Hereford-Brahman cattle, the Texas station concluded that Brahman blood makes for adaptation to pasture conditions, particularly at the lower altitudes and where insect pests are worst; that the Brahman grades do better than is generally believed when placed on full feed, but they do not often make so large gains as Herefords or Shorthorns; and that at the packing plants the Brahman grades show higher dressing percentages, but the carcasses are less desirable. There was also evidence that various contrasting characteristics in the Hereford and Brahman cattle such as color, conformation, disposition, and voice were inherited in a Mendelian manner.

Sheep.—Economical methods of managing and feeding continued to form the basis of the more practical problems receiving attention in the field of sheep production. At the North Dakota station, ewes bred to lamb at 14 months of age raised a very satisfactory lamb crop. At weaning time they weighed less than similar ewes that had not been bred, yet the difference in weight was due almost entirely to condition. The

greatest difference between the bred and the unbred ewes was in the quantity of wool produced. The early-bred ewes produced about 0.5 pound less wool than unbred ewes. At the Ohio station yearling ewes weighing 80 pounds at breeding time averaged 3 pounds less at 30 months of age after having raised a lamb than their unbred half sisters. Ewes weighing from 70 to 80 pounds and less than 70 pounds at breeding time averaged 5 and 15.5 pounds, respectively, less at 30 months of age than unbred ewes. At the second shearing unbred ewes averaged 1 pound more of grease wool per head than bred ewes.

The mineral content of the ration of ewes was found by the Kentucky station to have a pronounced effect upon their condition at lambing time. The blood serum of 7 normal ewes at parturition contained per 100 c. c. an average of 9.1 milligrams of calcium, 22.5 milligrams of potassium, and 5.1 milligrams of phosphorus, whereas the blood serum of 13 pregnant ewes suffering from acidosis contained 6.6, 44.1, and 5.7 milligrams of the respective minerals. The Ohio station found that rations containing a liberal allowance of legume hay have sufficient minerals for pregnant and nursing ewes, except where goiter trouble prevailed. Adding minerals to such a ration increased the birth weight of the lambs and also increased the percentage of difficult lambings from 14 to 39 per cent. The mineral supplement fed the ewes apparently had no effect on the vigor or condition of the lambs at birth or on the gains at subsequent ages.

Studying the growth of wool of Rambouillet sheep, the Texas station found that between the ages of 2 and 5 years the weight of the fleece of ewes was practically constant, reaching a maximum between 2 and 4 years of age. At the Washington station no marked variation was noted in the average length-growth of staples of wethers sheared in the usual manner and those carrying a 4-year fleece. There was little difference in the length of staple grown the first and fourth years, and in the length of staple grown in winter and in summer. Length-growth of wool differed little between a lot of bred ewes and one allowed to go dry.

In studies of color inheritance in sheep, the Ohio station found that black in Shropshire, Merino, and other common breeds as a rule was inherited as a recessive character. The chalk-face or frosted-face character of Merinos was evidently due to a combination of dominant factors. The New Hampshire station found that inbreeding resulted in a decrease in size after seven generations even though constant selection was practiced in the elimination of small-sized individuals. The inbreeding, however, brought about no reduction in fertility, and the percentage of twins increased.

The ridgeling character in sheep was found by the Ohio station to be hereditable, since all the ridgeling lambs dropped in the station flock were sired by one ram or by one of his sons or grandsons.

Feeding experiments, especially those attempting to utilize unsalable products, produced interesting results during the year. The Utah station found that even limited amounts of alfalfa chaff and barley straw were unsatisfactory in fattening rations for lambs. On the other hand, rice bran fed with barley to fattening lambs by the California station produced gains practically equal to those obtained with cottonseed meal and barley, and no ill effects were apparent due to the rice bran. Bean screenings and alfalfa hay proved to be an economical ration and produced fairly satisfactory gains. Cull raw potatoes were found by the Idaho station to be an excellent supplement to a ration of barley and hay for lambs. Cooking the potatoes added to the cost without increasing the gains or the finish.

Goats.—The Texas station found that by selection it was possible to develop a flock in which 50 per cent of the sons were ridgelings, whereas a flock in which no ridgeling sires were used produced 5.4 per cent ridgelings among the males. Anatomical and histological studies showed that the right testicle was always the one retained. It was small and was attached by membranes to the abdominal wall or to various organs. There was complete degeneration of the germinal tissue of the retained gonad although the presence of sperm was demonstrated in a few cases.

Swine.—During the past year a number of the stations have endeavored to determine the value of some new or little-used feeds in rations for swine. Although marine tankage, a by-product of the fish industry, did not produce so rapid or so economical gains as digester tankage at the Mississippi station, rather satisfactory results were obtained from its use as a protein supplement to corn. As a supplement to corn, the North Carolina station found whale meal to be less palatable and to produce slower gains than fish meal.

The Ohio station found that protein of dry-rendered tankage was worth from 6 to 9 per cent more per pound than the protein of ordinary steam-rendered tankage. Ground flaxseed as a supplement to barley for fattening swine produced larger and more economical gains than linseed meal, and in spite of its relatively high percentage of oil did not result in scouring.

Minerals continued to be an important phase of inquiry in nutrition studies with swine. At the Ohio station the rate and economy of gains was reduced when rock phosphate or sodium fluoride was added to a ration. The breaking strength of the bones of pigs fed rock phosphate was 50 per cent less than that of pigs fed limestone or bone meal, and sodium fluoride still further reduced the breaking strength. None of these minerals produced any marked difference in the ash content in the femurs of the pigs or in the calcium and phosphorus contents of the ash. Analysis showed fluoride to be present in quantities proportional to those fed.

Sows fed bone ash at the Missouri station farrowed normal-appearing pigs and secreted a normal quantity of milk, but all of the pigs died within a few days. Breeding difficulties were encountered with sows on low calcium diets and those that did conceive farrowed a high proportion of dead pigs. The addition of limestone or limestone and raw bone meal to a dry-lot ration of corn, tankage, and linseed meal at the Ohio station did not improve either the rate or economy of gains. A supplement of salt, limestone, and iron oxide produced as rapid and more economical gains than one of salt alone. By feeding iron citrate and copper sulphate in the ration of pigs farrowed in a barn and kept in cinder yards at the Illinois station anemia was prevented, while litter mates fed no supplement developed anemia. Feeding the minerals to the mother of a litter apparently did not benefit the pigs.

In a preliminary study of the food needs of pregnant swine, the Illinois station determined that during the first 12 weeks of pregnancy the uterus increases to 15 or 17 times the size of the uterus of the nonpregnant sow. The amniotic fluid increased in weight to the eighth week and then varied irregularly; the fetal membranes attained their maximum weight at the end of the ninth week; and fully two-thirds of the fetal weight developed in the last 4 weeks of gestation. From insignificant changes at the beginning of gestation, the uterus of a pregnant sow at the end of the sixteenth week was increasing in weight at the rate of 312 grams per day and was retaining 33 grams of protein, 272 calories of energy, 12 grams of ash, 4.29 grams of calcium, 1.98 grams of phosphorus, and 12.3 milligrams of iron per day.

Continued early breeding of well-fed sows by the Missouri station was not found prejudicial to the mature weight of the sow, but limiting their feed delayed mature weight indefinitely. However, the low plane of nutrition of early-bred sows did not inhibit skeletal growth. Neither the age of the sow, size of litter, nor plane of nutrition appeared to affect the length of the gestation period. The plane of nutrition of the sow affected the birth weights of her pigs. The birth weight of the litter ranged from 5 per cent of the live weight of sows weighing 400 pounds or more to 7.11 per cent of the live weight of sows weighing under 200 pounds. Post-mortem examination of sows on a low plane of nutrition showed that the growth of the genital organs was so retarded that sexual maturity was delayed until the animal was from 11 to 12 months of age.

Concerned with the cause of pigmentation in the ventral fat of pork known as "seedy belly" or "seedy cut," the Wisconsin station observed that one of the two types, black "seed," consisted of granular pigment identical with skin pigment in black and red hogs, and the other red "seed," was directly related to the sexual development and lactation activity of the sow. Red "seed" does not occur in barrows or gilts prior to puberty, but as the mammary gland becomes inflamed, particularly at heat, the red "seed" is prevalent and it becomes especially pronounced in pregnant sows. It appeared that black "seed" could be avoided by using white breeds, and that the red "seed," which did not occur in barrows, could be reduced in gilts by slaughtering before puberty or when the sows were not in heat.

Studying the inheritance of color in swine, the Ohio station observed that Poland-China black was due to a single pair of dominant factors, and that the amount of black was controlled by another pair of factors. Red was due to two pairs of factors, and its occurrence was influenced by other factors which were recessive and might result in very dilute cream or even white pigs. Two pairs of recessive factors seemed to be responsible for the inheritance of hernia.

Horses and mules.—The economic feeding of horses and mules continued to gain in importance as a subject for sta-

tion research. The Alabama station found that in comparison with timothy hay, Johnson-grass hay was as palatable, maintained the animal in practically the same flesh whether doing light or heavy work, and reduced the average daily feed cost. The animals did not differ in health and vigor or in ability to work, on the two kinds of hay. When fed with ear corn at the Mississippi station, an average of 11 pounds of Laredo soybean hay was equal in feeding value to 12 pounds of Johnson-grass hay.

The use of self-feeders at the Mississippi station made it possible to fatten mules doing heavy work and to carry them in good condition. The self-feeder eliminated waste, gave each animal an equal opportunity to share in the feed, and required less time than hand feeding. Fewer cases of digestive disorders occurred, and the gains in weight and the ability to endure heat were not affected.

The South Carolina station found little difference in the efficiency of a ration of shelled corn and grass hay and a ration of shelled corn, cottonseed meal, and grass hay when fed to team mates of eight mule teams. There was, however, considerable variation in the quantity of cottonseed meal consumed when 0.75 pound of meal replaced 1.5 pounds of corn. At the Texas station horses received either 1 or 2 pounds of cottonseed meal per head daily for a year without mortality, blindness, or loss of hair coat, and did not suffer any more from colic or heat than similar animals receiving no cottonseed meal. No specific injurious effects were noted on the general health or fertility of young stock.

Mules used for heavy farm work at the Mississippi station differed markedly in their individual needs for salt when it was available at all times, the average daily consumption being 0.4 ounce per 1,000 pounds of live weight. Consumption was higher during spring and summer, being as high as 0.46 ounce per 1,000 pounds of live weight during the period of heavy work and decreasing to about 0.3 ounce during the fall and winter.

Poultry.—Incubation studies to determine the factors involved in the hatching of eggs under artificial conditions are in progress at a number of stations. High humidity was found by the New York Cornell station to aid in the transfer of calcium from the eggshell to the body of the chick embryo and also to favor the growth of the embryo during the first part of the incubation period but was very detrimental just prior to hatching. The best hatching results were obtained at the Wyoming station when evaporation varied from 12 to 15 per cent for eggs not over 4 days old and 12 to 13 per cent for eggs from 10 to 12 days old at the time incubation started. Cooling eggs was especially valuable with high incubation temperatures, retarding development and slowing down evaporation. The temperature requirements of hatching eggs were the same with a relative humidity of 50 per cent at high altitudes as at low altitudes. Relative humidity and egg temperature were found to be directly related.

The Nebraska station found a significant difference in the mean weights of male and female chicks as early as 1 week of age and that the difference thereafter widened with increased age. This finding suggested a factor for bringing lots with different numbers of male and emale chicks to a common basis for purposes of comparison. Studying the rate of growth of Rhode Island Reds, the Massachusetts station observed that at hatching chicks from large-egg dams averaged about 6 grams heavier than those from small-egg dams. At 4 weeks of age chicks from large-egg dams were about 27 per cent heavier, but at 21 weeks this difference had disappeared. Early-hatched chicks were 13 per cent heavier than late-hatched chicks at 2 weeks of age, 29 per cent heavier at 4 weeks of age, 22 per cent heavier at 16 weeks, and 17 per cent heavier at 21 weeks, even though the mean difference in hatching weight of early and late hatched chicks was not large. Chicks from hen mothers were 5 per cent heavier than those from pullet mothers at hatching time, 9 per cent heavier at 4 weeks, and 7 per cent heavier at 16 weeks, while at 21 weeks there was no significant difference.

Dealing with the effect of inadequate rations upon chicks, the Missouri station found that the blood and bones of chicks on rations deficient in vitamin A were normal, whereas rations deficient in vitamin B apparently raised the level of blood sugar, and rations deficient in vitamin D resulted in a decrease in the ash content of the bones. The adrenal glands of chicks weighing over 800 grams and receiving synthetic rations were much heavier than the average of those of chicks on adequate rations.

At the New Hampshire station, chicks fed 2 per cent of cod-liver meal weighed more at 7 weeks of age than chicks receiving from 1 to 4 per cent of cod-liver oil and also had better appetites. Excessive feeding of cod-liver oil resulted in slow and uneven growth, and pale shanks were characteristic of chicks so fed. The hatchability of eggs

produced by pullets fed cod-liver meal was 75 per cent as compared with 64 per cent for the eggs of pullets fed cod-liver oil, and of the fertile eggs set the hatchability was 84 and 75 per cent, respectively. Cod-liver oil stearin, a by-product of medicinal cod-liver oil, prevented external signs of rickets when fed at levels as high as 1, 2, or 4 per cent. Feeding at the 4 per cent level retarded growth to some extent.

The factors, other than feed, which influence egg production have been studied at several of the stations. At the Massachusetts station negative correlations were found for egg production previous to molt and the number of eggs laid in 365 days by pullets and for length of molt and second-year egg production. Inbreeding studies showed that the only desirable effect of hybrid vigor from the viewpoint of fecundity was greater body weight. Sexual maturity was not retarded consistently or regularly by inbreeding, nor was the body weight at first egg affected. Winter pause, low intensity, and low persistency probably accompanied the inbreeding practice. Inbreeding tended to lower production, decrease fertility, lower the sex ratio, reduce chick and first-year laying vigor, and probably decrease hatchability. Senescence was found by the West Virginia station to decrease egg production from the first to the second year 20 per cent, and from the second to the third year 22 per cent. The average weight per egg increased 6.8 per cent from the first to the second year, but no significant change was noted in weight per egg from the second to the third year. The average total weight of eggs laid per bird decreased 22 per cent during the third year as compared with the second year.

The Missouri station found no disadvantages in having general-purpose hens start to lay at an early date, nor in the annual egg production of White Leghorn pullets hatched at an early date as compared with those hatched later. A consistent relation between early maturity and high winter egg production was observed by the Iowa station. The maximum winter egg production was obtained when the birds matured in less than 220 days. Practically no relationship existed between maturity and spring egg production, and the relation of maturity and total egg production varied widely from year to year.

In studies of pigeon hybrids, the Wisconsin station found that the offspring of certain crosses were entirely or almost entirely of one sex. Upon examination of the chromosome constitution of these individuals it was definitely determined that the high mortality observed was due to the death of one sex in the early embryonic stages.

As a result of 20 years of breeding work, the New York Cornell station found that fecundity was an inherited character in fowls. Through the mating of high-producing birds only, pullet egg production was increased 78 eggs per bird. In another line in which low to medium producing birds were mated the increase in egg production was but 32 eggs per bird. The high line laid the first egg at an average age of 209 days, and the low line at 231 days. The average body weight of the birds in the high line increased 1 pound, and in the low line about 0.5 pound.

The rate of feather growth, as determined in Barred Plymouth Rocks by the Kentucky station, was slower in males than in females, and the rate of feathering in the chick was closely associated with the rate of growth and with the rate of sexual maturity. The quality of barring of slow-feathering birds approached the standard for the breed more closely than that of rapidly feathering birds. There were, however, few good layers among the birds showing the highest standard of barring in the feathers.

The Kansas station, in studying chick down-color variations in Rhode Island Reds, found that a single factor difference with the absence of dominance appeared to account for most of the variation between dark and light down color, and that there was little association between the color of the down and the adult color, except that smut and white in the under color were associated with the grade of down color. It appeared that chicks having the lightest shades of down might develop into very light adults, whereas chicks of the dark type seldom produced adults with the lighter shades of red.

Mortality among chicks, according to Kansas station studies, was significantly reduced in crossbreds of White Leghorns and Rhode Island Reds as compared with the parent breeds. The hybrids of both sexes outgrew the purebred offspring, but the cross of Leghorn male on Rhode Island Red female produced hybrids which grew more rapidly than those of the reciprocal cross. Females of the cross Leghorn male by Rhode Island Red female were slightly slower in reaching maturity than White Leghorn females, while females of the reciprocal cross were more nearly intermediate between the two purebreds.

Of 2,501 chicks and embryos dying after 14 days of incubation, the Iowa station found that 46.82 per cent were

males. Variations in the sex ratio of different groups did not appear to be related to the time during the hatching season in which the eggs were set, colony in which the eggs were produced, antecedent egg production, or age of the hen. There was no evidence of selective mortality of either sex prior to hatching.

Dairy cattle.—Since dairy cows during lactation require a large quantity of minerals for the milk produced, the supplying of this heavy demand has been an important problem. The Michigan station, in a prolonged feeding experiment, showed that mineral supplements carrying phosphorus and calcium are not needed in the ration of growing cattle and milking cows fed a good quality roughage and a protein supplement. A mixture of steamed bone meal and salt, equal parts, supplied the phosphorus deficiency of a ration of legumes and cereal grains without protein concentrates. In goitrous regions a mixture of 0.05 pound of pulverized sodium or potassium iodide and 100 pounds of salt should be added to the ration.

No beneficial effects were noted at the Ohio station either upon the health or milk-producing abilities of cows fed dicalcium phosphate. Growing dairy animals on rations low in calcium or calcium and phosphorus at the West Virginia station thrived about as well as normal-fed animals for some time, but over a period of two years did not obtain the same weight or height at withers. Animals on low phosphorus diets grew as well as normal-fed animals over a period of two years, even though the inorganic phosphorus content of their blood was below normal. These animals could not draw enough phosphorus from their bones to maintain the inorganic phosphorus of the blood. The bones of animals fed rations containing less than 0.35 per cent of calcium or less than 0.2 per cent of phosphorus were low in ash but high in moisture and extractable material. However, the proportion of calcium and phosphorus in the ash of the bone remained about the same regardless of the ration. The Massachusetts station found that mineral supplements had little or no effect upon the rate of growth of young animals, upon milk production, or upon the composition of the milk. A low-ash ration did not affect milk production adversely.

Ultra-violet light, in Wisconsin station studies, had little, if any, effect on the calcium and phosphorus metabolism of dairy cows, no apparent influence upon the calcium and phosphorus content of the milk produced, nor any influence upon the quantity produced. Cod-liver oil did not favor the calcium assimilation of rather heavy milking cows, and the oil was poorly, if at all, absorbed from the intestinal tract. Irradiated yeast showed no positive evidence of improving the calcium assimilation of heavy-producing cows, although the vitamin D was absorbed in the blood. The absorption, however, did not change the calcium or inorganic content of the blood or of the milk produced.

The possibility of raising strong, healthy, vigorous calves by feeding milk substitutes or supplements to whole milk has been investigated by a number of stations. The Maryland station found that large vigorous calves could be changed from liquid feeding when from 30 to 45 days of age, while less vigorous calves should be continued to 60 days of age. The nurse cow was quite satisfactory for raising delicate and valuable calves, whereas the hand feeding of whole milk was too costly. At the Ohio station calves fed milk for from 90 to 120 days consumed more hay than those fed milk for only 60 days. From the viewpoint of development of the calves 60 days was too short a period to feed milk, and 120 days was too long to be economical. Weaning had less effect on calves that received their milk in the form of dry powdered skim milk.

Cows at the Virginia station receiving as a protein supplement Hevea rubber-seed meal, a by-product from the processing of the kernels of the seed of the Para rubber tree, produced somewhat more milk and slightly less butterfat than when they received linseed meal. The results indicated that Hevea rubber-seed meal may be used as a medium protein concentrate in rations for dairy cows, and that it is palatable without bad physiological effects, and apparently equal to linseed meal for supporting milk production. Cows fed potatoes at the North Dakota station produced a little more milk and a little less butterfat than when fed corn silage. The potatoes were not quite so palatable as and were more laxative than the corn silage. No off-flavor milk was produced, and butter made from sweet cream produced by cows fed potatoes compared favorably in flavor, body, and iodine number with butter made from the same cows when fed corn silage. Sweet corn cannery-refuse silage was found by the Illinois station to be rather unpalatable when fed alone, but was readily eaten as a supplement to pasture or dry-lot feeding.

Studies of insensible perspiration of dairy cows by the New Hampshire

station, cooperating with the Carnegie Institution, indicated that the daily loss of weight due to excretion of carbon and water vapor through the lungs and skin acts as a safety valve by which the animal eliminates excess heat under high pressure of metabolism. Daily changes in feed consumption, humidity, and environmental temperature seemed to affect the insensible perspiration without changing the milk flow.

HENRY W. MARSTON.
GEORGE HAINES.

DAIRYING

Problems dealing with the quality and keeping properties of the various dairy products are being given particular attention by the experiment stations, and various new and improved dairy processes have been devised.

Normal milk relatively high in lactose and relatively low in chloride was shown by the California station to have usually a sweet, pleasing taste, whereas milk low in lactose and high in chloride had an unpleasant and often an astringent or salty taste. Feeding molasses did not increase the lactose content of the milk, and adding sodium chloride did not increase the chloride content of the milk abnormally. The milk produced by cows receiving oat hay had a pleasing taste, evidently due to some constituents other than the carbohydrates of the hay, while a feed flavor was noticeable in milk from cows on alfalfa hay.

In a method devised by the Tennessee station for removing the bitter substance from the cream produced by cows eating bitterweed (*Helenium tenuifolium*), the bitterweed-flavored milk is separated in the usual way, uncontaminated sweet skim milk is added to the cream, and again separated. While water may be used if good skim milk is not available, it gives the cream a watery taste. No way to make the bitter skim milk usable for food has been found, although the curd and the milk sugar prepared from the whey may be freed of most of the bitter substance.

The storage of dairy products for later use, now a common practice, has been a fruitful source of problems for investigation. The Vermont station, from its experiments, recommended that only cream of the best quality should be frozen and stored in containers free from corroded or bare spots of iron or copper. Properly lacquered, granite, or agate-coated cans gave best results, although well-tinned containers were suitable for this purpose. Properly handled, high-quality cream could be frozen and stored for at least 6 months with little or no deterioration in flavor. The storage temperature recommended for high-grade cream, butter, and butter oil was 0° F. The keeping quality of butter oil markedly surpassed that of average-quality cream and butter. The Connecticut Storrs station found that after 2 months' storage at 10° the milk proteins of both raw and sterilized skim-milk groups began to precipitate. No precipitation occurred in either group when held for 3 months at −14°, but by the end of 6 months the raw milk developed a cardboard flavor.

The Illinois station found that honey could replace from 50 to 100 per cent of the sugar in an ice-cream mix, although difficulties encountered in freezing usually made it not advisable to substitute more than 75 per cent of the sugar with honey. For an appreciable honey flavor 9 per cent of honey was necessary, while from 14 to 18 per cent was more satisfactory. Honey ice cream could be stored for several weeks without impairment of flavor, which was not affected even by the addition of beeswax. At the Massachusetts station it was found that varieties of fruit best suited for freezing were also best for use in ice creams. About 15 per cent of cold-packed strawberries, from 8 to 10 per cent of raspberries plus a suitable quantity of raspberry extract, from 15 to 20 per cent of peaches with extract, and 12 per cent of cherries were found to give optimum flavor in a mix. Freezing a fruit mix without sugar or substituting corn sugar for cane sugar resulted in an undesirable ice cream.

The whipping properties of the ice-cream mix were partly destroyed at the Kansas station by the substitution of butter for sweet cream. At the New York Cornell station mixes containing butter did not develop so much swell and required nearly twice as long to reach a 90 per cent overrun as mixes containing cream. Increasing the sugar content of ice-cream mixes at the Michigan station had a depressing effect upon the incorporation of air, particularly when more than 13 per cent of sugar was used, and also prolonged the time required for maximum overrun. Each 2 per cent increase in sugar content increased the specific gravity approximately 0.2 per cent and lowered the freezing point about 0.4°. Mixes containing from 15 to 17 per cent of sugar scored highest in body and texture, but the optimum sugar content seemed to be between 13 and 15 per cent.

The species of mold, the humidity, the oxygen supply, the temperature and

time of storage, and salt concentrate were found by the Minnesota station to affect the growth of molds in butter, these factors apparently acting independently or collectively. Samples of butter low in mold, yeast, and total counts of bacteria tended to keep slightly better than those with high counts, but such counts on individual samples were not deemed reliable indexes of the keeping quality of the sample. The inoculation of fresh milk or butter with organisms isolated from off-flavored butter at the Michigan station was quite apt to produce off flavors identical with, or similar to, those present in the original butter.

Freezing injures the texture of cheese, but the Wisconsin station found that this injury may be overcome by six weeks' storage at normal storage temperature, flaking off of the paraffin coating being the most objectionable effect of freezing. Changing the acid reaction of processed cheese gradually up or down caused the body of the cheese to become hard rapidly, but further changing as rapidly decreased the strength of body. When the reaction approached neutrality the cheese tended to putrefy during storage, while the more acid cheese did not change. In the manufacture of cottage cheese at the Missouri station the addition of a small quantity of gelatin reduced the yield of cheese but increased the amount of solids recovered from a known volume of skim milk. Gelatin improved the aroma, flavor, body, and texture of the cheese at the end of a storage period as compared with cheese containing no gelatin. In contrast to ordinary cheese, cheese containing gelatin and stored at 0° F. had smaller ice crystals, wheyed off less when thawed, and shrank little as a result of the expulsion of the whey.

HENRY W. MARSTON.

ANIMAL DISEASES

Experiment station investigations with animal diseases continued to make consistent progress during the year. Infectious abortion, pullorum disease, fowl pox, and various internal parasites have been responsible for a large part of recent station activities in this field, but many other significant investigations were reported during the year.

Infectious abortion.—The advance in knowledge of the importance of infectious abortion from the sanitary health viewpoint, aside from its economic importance, continued to stimulate the work. In observations on an aborting herd during 32 years the Nebraska station found the average monetary loss per abortion to be $158 based on sale of milk, or $134 based on sale of butterfat. In the control work with the herd of cattle at the Washington station in which the agglutination test has been made periodically since 1923, every animal negative at the time of the first application of the test remained negative on each subsequent test. Georgia station work indicated that under the test conditions in pastures exposed to the sun the abortion organism does not survive so long as four weeks. That the swine type of the organism generally can be distinguished from the bovine type by its luxuriant growth and yellow pigment in old agar cultures, notwithstanding its close morphological and cultural resemblances, was pointed out by the Illinois station.

Milk of cows that had been fed the abortion organism but had not aborted was proved by the Wisconsin station to contain the organism, demonstrating that the udder may become infected before abortion occurs and that milk may act as a carrier of the infection even though the cow producing it has not aborted. Such cows, however, usually react to the blood test and can thus be identified. In eradicating infectious abortion through the segregation of positive and negative reacting cows at the Western Washington station, 49 nonreacting cows and heifers added to the original nonreactors, with a single exception, continued to be nonreactors. Further work by the Michigan station showed that the turkey, pheasant, pigeon, duck, and goose are susceptible to the abortion organism, the turkey being especially susceptible.

Tuberculosis.—The California station reported that subcutaneous vaccination of cattle with Calmette-Guérin bacillus conferred sufficient resistance to protect against the fatal effects of intravenous or subcutaneous injections of virulent tubercle bacilli. Its chief protective effect appeared to be in retarding the extension of tuberculous processes resulting from infection received subsequent to vaccination. The Wyoming station work clearly indicated that skin lesions of cattle are truly tuberculous, although the organism is much less active than that ordinarily found in tuberculous cattle.

Hemorrhagic disease.—In continuation of control work with the hemorrhagic disease that occurs in Nevada and neighboring States successful results were obtained by the Nevada station in tests made with a second form of vaccine, no cases of the disease appearing in more than 600 head thus vac-

cinated. A sugar-free mineral mixture agar was prepared by the Kansas station for use in differentiation of the hemorrhagic-septicemia organism from related organisms. The experimental feeding of oxalic acid to cattle by the Western Washington station failed to cause the red water or cystic hematuria.

Botulism.—Botulism antitoxin was used by the Utah station with fairly satisfactory results in animals showing symptoms of the disease formerly known as forage poisoning.

Sterility of mares.—Further study of the sterility of the mare wherein the Kentucky station isolated *Bacterium viscosum equi* from more than 50 per cent of the foals examined, led to the conclusion that the microbe is nearly always present in the oral cavity of the horse, and suggested the possibility that adult horses actually serve as infection carriers or as reservoirs for this particular organism.

Lamb dysentery.—The Montana station observed that the form of lamb dysentery occurring in that State differs from that met with in Great Britain, apparently being a shed infection and seldom occurring in lambs born on grass in late April or May. Cold wet weather was found to be the principal factor in the occurrence of the disease, with shed sanitation next in importance. Field observations by this station of a disorder known as stiff lambs indicated that it occurs largely in lambs confined to small pens and sheds during the first two or three weeks of their life, and later permitted an unusual amount of exercise on pasture.

Alkali disease.—A preliminary survey by the South Dakota station indicated that the so-called alkali disease affects an area equal to 30 per cent of the entire State. Autopsies made of afflicted animals showed that besides loss of hair and hoofs the normal bone structure is also affected and possibly some of the organs.

Arsenical poisoning.—Alfalfa hay harvested and stacked by the Utah station 10 days after being dusted with calcium arsenate at the rate of 6 pounds to the acre was fed to horses, cattle, and sheep six months later. Although fed all that they would consume twice daily for 80 days, the animals were found to have gained in weight and to be in the best of health.

Lunger disease of sheep.—The Utah station failed to transmit lunger disease from affected to uninfected sheep either by contact or by inoculation. Severe or rough handling of the sheep on the range or in the corrals is thought to be the cause of the disease.

Liver fluke.—The discovery that the snail *Lymnaeae* (*Galba*) *bulimoides* serves as an intermediate host for the liver fluke of ruminants in the United States was first reported by the Oregon station, and later confirmed by the California station. The snails were found to be destroyed by copper sulphate broadcast, but such destruction did not prevent their reappearance on the same pastures the following year. The Porto Rico station determined that goats may be given carbon tetrachloride in doses of 1 cubic centimeter per adult animal with safety and with a high efficiency in removing liver flukes. The intermediate snail host was discovered to be very sensitive to such chemicals as copper sulphate, salt, and lime, a dilution of 1 part copper sulphate to 1,000,000 parts of water killing it in a few hours under laboratory conditions. However, under Porto Rican conditions, the spreading of lime on wet pastures and grasslands was found more practicable as a control measure.

Stomach worms of lambs.—Regular monthly treatments by the Ohio station of lambs infested with stomach worms with copper sulphate solution proved 97 per cent effective.

Kidney worm of swine.—In experiments with the kidney worm of swine at the Florida station the eggs were induced to hatch in less than 24 hours when kept in a moist chamber in the incubator. Experimental animals were infested by larvae administered through the mouth and also through the nostrils, and infestation also took place where larvae were placed on the intact skin. Large numbers of the larvae were recovered from the livers of the animals infested in this way. The Porto Rico station first indentified the larvae of the swine kidney worm in the urine of a young pig on the twenty-eighth day after it had been heavily infested with larvae grown in the laboratory. When the pig was slaughtered a few days later, many of the worms had reached the ureters, but only a few were mature, and several of the intermediate forms had not started to migrate through the liver.

Pullorum disease.—Research with pullorum disease was continued, particularly with an aim to facilitate means for its detection in the fowl and its control or even eradication. Agglutination testing for pullorum disease at the Arkansas station led to the recommendation that a foul whose blood serum

agglutinates a suspension of the organism in a dilution of one to ten should be considered a carrier of pullorum infection. An antigen containing 0.04 per cent of sodium hydroxide appeared to be the most efficient in preventing cloudy reactions.

The slide or rapid method of applying the agglutination test was found less accurate than the tube method in detecting pullorum infection by both the Kentucky and Montana stations, the latter station considering this to be due largely to the unfavorable conditions met with in poultry-house testing. Comparing the plate and tube tests for detection of the disease, the Western Washington station found complete agreement in the results from the two methods in a high percentage of the tests. The California station concluded that repeated agglutination testing at intervals of from one to two months offer a reasonably certain method of eradicating the disease from a flock in one season.

The Minnesota station found that the causative organism of pullorum disease can be isolated from the livers of affected baby chicks in a large percentage of the cases, 92 per cent in down-covered chicks, and 76.7 in chicks from 3 to 8 weeks of age. The organism was isolated in an average of 73.4 per cent of the times from the yolk and 66.3 per cent from the heart's blood in the down-covered chicks, while in the chicks ranging from 3 to 8 weeks of age the corresponding percentages were 39.6 and 50.5. Its transmission experiments with pullorum disease in chicks led the Rhode Island station to conclude that the seat of post-hatching infection is more often in the digestive than in the respiratory tract. Formaldehyde fumigation, the Kansas station found, satisfactorily sterilized incubators of the forced-air draft type regardless of whether all ports were closed or left open. The Michigan station found that poults in two flocks that had been raised with baby chicks contracted pullorum disease.

Fowl pox.—The significance of fowl pox to the poultry industry has resulted in considerable activity during recent years in the search for an effective means of vaccination against it. To the so-called scarification and follicle methods previously recommended, the Oregon station has added a so-called stick method that was found to be highly satisfactory. According to this method, the virus is introduced through an incision in the skin of the thigh made three thirty-seconds of an inch deep with a sharp-pointed blade. The small amount of virus used, rapidity of vaccination, and uniformity of takes especially recommend it. Michigan station experiments confirmed results of others showing cutaneous vaccination with a living virus to be practical, effective, and quite safe in protecting against fowl pox when applied to young and healthy birds. By vaccinating flocks at the first sign of fowl pox, the station invariably was able to stop the outbreak in from four to six weeks. A lasting immunity was obtained at the New Hampshire station through the use of any number of follicles, from 3 to 12, if a "take" results. It is concluded that Rhode Island Red pullets from 2½ to 5½ months old may be successfully immunized. The Massachusetts station found it safe to vaccinate birds cutaneously for fowl pox as they were transfered from the range to laying houses, even though they were in early egg production at the time. The use of the standard cutaneous vaccine in a flock that was in the early stages of fowl pox infection and but slightly affected, apparently prevented further spread of the disease. Inoculation with virulent virus suspensions on the combs of cutaneously immunized birds showed that the duration of immunity for fowl pox was at least 371 days.

Infectious bronchitis. — The Western Washington station found that the causal agent for infectious bronchitis of the fowl was removed by filtering through earthen filters and apparently was destroyed by heating to 60° for 1 hour, by drying at 104° F. for 8 hours, and by prolonged storage at room temperature or in the ice box. At the New Jersey stations it was preserved in dry form for 47 days; in a water or glycerine solution at room temperature it became inactive in a few days, while at 22° it remained active for a long time.

Brucellosis of poultry.—Numerous cases of natural infection of domestic fowls with the infectious-abortion organism were reported by the Michigan station. The disease occurred principally on farms where birds were allowed to follow infected cattle and hogs or where the infected products of such animals might be consumed by the birds. Experiments showed that the turkey, pigeon, pheasant, duck, and goose are susceptible to infection with the three forms of the organism, namely, bovine, porcine, and avian, when fed massive doses, but that the rate of mortality is not nearly so high as in the chicken. Attention was called to the possibility that pigeons and pheasants may prove to be a means by which the organism is

spread, since they often feed in farm lots that may harbor infected animals.

Blackhead of turkeys.—In experiments by the North Dakota station, turkey poults were kept, without any loss from blackhead, on a rotated clean alfalfa range not used before for other poultry, whereas all but 4 of 45 poults were lost when placed on a range formerly used for chicken ranges and separated from the unaffected lot by a 20-foot driveway. At the Missouri station the utilization of food by abligated turkeys, i. e., those operated upon and the ceca ligated, was the same as for the unabligated birds. Sixty birds receiving cecal abligation remained healthy, whereas 37 of 45 not operated upon contracted the disease. The partially abligated birds were more than twice as resistant to enterohepatitis as unabligated ones. Studying blackhead, the Rhode Island station discovered a bacterium in the blood stream of affected turkeys which was pathogenic for baby chicks, pigeons, and turkey poults, and may prove to be either a causative agent of blackhead disease or a secondary invader.

Coccidiosis.—The mortality in chicks inoculated artificially with coccidia was reduced by the Pennsylvania station from 65 to 5 per cent by keeping the feed free from droppings of affected chicks. Frequent removal of the litter reduced the mortality from 38 to 52 per cent down to 5 per cent. In a flock of young birds severely infested with coccidiosis, the Rhode Island station found that the feeding of sour milk was quite effective in checking losses. Metaphen administered by mouth and per rectum was found to be quite valuable.

Other diseases and parasites of poultry.—In a study of fowl cholera, the New Jersey stations found that the carrier state for the infection, once acquired, is not necessarily maintained, indicating that a wide variation exists in the degree of resistance to this disease. The Pennsylvania station failed to detect any relationship of big-liver disease to bacteria or parasites. Fowls evidencing paralysis were observed by the Rhode Island station to be infested with roundworms and tapeworms, cecal worms being almost constantly present. Attempts to transmit the disease artificially were unsuccessful. Of several drugs used only strychnine appeared to give beneficial results. Examinations made by the Montana station of birds from 32 flocks, where leg weakness or various nervous symptoms accompanied the loss of hens, showed that either roundworm or tapeworm infestation was the direct cause of the loss. The treatment of tapeworm-infested flocks with 1-gram kamala tablets brought about almost immediate relief. The use of 1 cubic centimeter capsules of tetrachlorethylene was quite effective in the case of roundworm infestation. Roundworms were removed by the Kansas station with scarcely any ill effect upon the chickens by the administration of tetrachlorethylene at the rate of 4 and 6 cubic centimeters per kilogram of body weight.

WILLIAM A. HOOKER.

FOODS AND HUMAN NUTRITION

Much yet remains to be learned concerning foods—their composition, the best means for their preservation without spoilage or loss in palatability, and new methods of utilization and preparation. Are children receiving the best foods for growth and developement? Is the family diet well selected, and what is the cost of an adequate diet in any particular section of the country? These problems are being studied at the various experiment stations. Nutrition investigations are wide in their scope and include problems in the metabolism of carbohydrates, fats, minerals, and vitamins. Most of these are long-continued investigations of which the year's progress constitutes only a small part.

FOOD PRESERVATION, UTILIZATION, AND PREPARATION

Problems connected with the preservation of foods by storage, drying, freezing, and canning, and with the development of new ways of utilizing fruits and vegetables received considerable attention during the past year at many of the stations.

Storage.—A study of storage possibilities in Oklahoma led to the conclusion that the temperature and humidity conditions in the State are such that the prospects for common storage of vegetables are poor unless properly insulated cellars are used. As a substitute sun drying is suggested as noted later. Storage conditions were found by the Maine station to be an important factor for potatoes which are to be used for potato chips. Cold storage increases the sugar content of potatoes, and potatoes with a high sugar content become too dark on frying. After the potatoes are removed from cold storage and left in a warm place for a short time, they fry to a lighter but not very uniform color. Storage conditions may also affect the antiscorbutic properties

of potatoes. At the Montana station a comparison of Netted Gem potatoes after storage all winter in a cool damp cellar and a fairly warm, dry cellar respectively, showed that the potatoes stored in the warm, dry cellar, although somewhat shrivelled and sprouted, had a higher vitamin C content than those stored in the cool damp cellar.

Drying.—Directions for the home drying of vegetables have been published by the Oklahoma station. Of 11 vegetables tested, okra gave the most satisfactory dried product, with beets ranking second. Studies at the California station on the rôle of sulphur dioxide and sulphur trioxide in the preparation and storage of dried fruits showed that sprinkling apricots before sulphuring retards, and dipping them in hot lye increases the rate of absorption of sulphur dioxide. Dried sulphured apricots held at 65° to 70° F. for six months lost about 50 per cent of their sulphur dioxide content, while fresh sulphured apricots held at 32° for eight months lost about 25 per cent and at 0° about 15 per cent of their sulphur dioxide content. Sulphuring was found to protect dried peaches, apricots, and prunes against loss of vitamin C and possibly also of vitamin A. Current practices in the use of suphur dioxide in preparing cut fruits for drying; Federal, State, and foreign regulations concerning it; and the relative methods of evaporation, sun drying, and dehydration for various fruits were summarized in a station bulletin.

The addition of olive oil, coconut oil, mineral oil, or glycerin to the lye dip used in preparing bleached Sultana raisins was reported by the California station to give a gloss to the dried fruit, but not to protect it sufficiently against insect infestation. A dehydrated Sultanina (Thompson Seedless) raisin has been developed by the station.

Freezing.—The California station found that nonacid vegetables can be preserved satisfactorily in freezing storage if blanched or stored in dilute brine. Since freezing does not destroy the spores of *Clostridium botulinum* such vegetables should be cooked thoroughly before tasting. Fruits frozen in dilute sirup were found to be superior in flavor and color to those frozen without sirup. In Massachusetts station studies of the best varieties of strawberries and raspberries for frozen storage and of the optimum ratio of fruit to sugar for these berries and for peaches, ratios of 2 to 1 and 3 to 1 were found optimum for strawberries and 3 to 1 for raspberries and peaches. Corn sugar proved unsatisfactory as it discolored the fruit. Fruit frozen at 0° with optimum proportions of sugar and kept at 15° remained in good condition for over a year and compared favorably with fresh fruit for use in ice cream, jams, jellies, and juices.

A long-continued investigation at the Georgia station of the best means of preserving Georgia fruits by the freezing method reached the commercial stage with peaches. For sliced peaches a 30 to 35 per cent sugar sirup is recommended in the ratio of 1 part to 3 of the peach tissue by volume, with packing in small containers, freezing at temperatures of −50° to −100° F. and storage at 10°. A bulletin issued by the station gives complete directions for preparing, storing, retailing, and serving of the frozen peaches.

Canning, pickling, and preserving.—Hydrogen-ion concentration was found by the California station to be an important factor in the appearance and keeping qualities of canned fruit, bottled fruit concentrates, olives, and pickles. The hydrogen-ion concentration of crushed pears in cans showing corrosion was found to be pH 4.3, while that of other samples canned in the same way and in good condition was pH 3.6. In the canning of prunes, swelling of the cans from the formation of hydrogen gas after canning was found to be retarded by the addition of fruit acid, and also by the use of large cans with large head space, short blanching, and relatively high sugar concentration in the sirup. Hydrogen-ion concentration was found to be an important factor in the rate of darkening of grape concentrates. In the treatment of ripe olives, it was found that heating at 120° F. in the presence of sufficient sodium hydroxide to give a pH value of 9.4 to 10 caused no noticeable effect in flavor or texture, but that for pasteurization at 180°, lower pH values—about pH 8.6 to 8.8—were necessary to prevent softening and the development of a scorched taste. The salt concentration required to prevent growth of Mycoderma in cucumber juice was found to be greater at values near neutrality than at low hydrogen-ion concentration. Methods were developed by the station for pickling green olives.

In further study at the Massachusetts station of methods of canning onions, a short blanching process, from one and one-half to three minutes in boiling water, was found to loosen the outside skins and facilitate their removal. The use of zinc-enameled tin cans prevented blackening of the onions, probably

because the compound from the liberated sulphur with zinc is white, while tin sulphide is black.

The standardization of methods of preparing blackberry jelly, blackberry jam, and cherry preserves at the West Virginia station was completed, and the results of the investigation were reported in a technical bulletin and in a popular circular, the latter containing practical directions for the housewife. Blackberry jam prepared by the methods described, if scoring 90 or above from a sample sent to the station, are entitled to carry the Mountain State Brand label. Simple pectin and acid tests were developed to determine the amount of sugar to add in jelly making. If these calculations are made, cooking a definite weight is considered to be the most accurate means of determining doneness in jellies. For making cherry preserves, the points considered of chief importance were the variety and the ripeness of the cherries, the quantity and method of adding the sugar, and the temperature of cooking.

New ways of utilizing fruits.—Candied cranberries were recommended by the Massachusetts station as being superior in many ways to the commonly used candied cherries. Various ways of using prune pulp, suggested by the California station, included its use in a prune and cereal food containing over 70 per cent of the pulp, and in bread and Danish pastries. Recipes on a commercial scale were developed at the station for the utilization of grapes and raisins in the manufacture of candy, water ices, and ice creams.

Meat cookery.—Methods of cooking veal were studied at the North Dakota station, and methods of cooking beef at the Missouri station. The chief problem in roasting veal is to overcome the dryness in cooking caused by the high content of water and low content of fat. According to the new technic of roasting with thermometers inserted in the meat, the method recommended by the North Dakota station for roasting the thigh or loin of veal is to sear the roast in the lower half of a double roaster in an oven at 527° F. for 15 minutes, cover, and continue the roasting at 275° until the internal temperature of the meat registers 160°. This requires a cooking time of about 20 minutes a pound. Veal chuck larded with salt pork and roasted slowly in a cast aluminum drip-drop kettle over a surface burner is said to be very palatable and to require only about one-fifth as much gas for cooking as does roasting.

At the Missouri station methods of roasting the tougher chuck cuts of beef were studied. In one of the two methods found most desirable, the meat is placed in the cold oven and the regulator then set at 450° F. for 30 minutes, after which it is reduced to 300°. In the other the temperature throughout the entire roasting period is 325°.

FOOD COMPOSITION

It is becoming more and more evident that the composition of natural foods depends upon many factors and that generalizations can not be made. This is particularly true of those constituents which are present in very small amounts, such as some of the minerals and the various vitamins. Determinations at the Wisconsin station of the calcium and of the phosphorus content of canning peas of the smooth and the wrinkled varieties grown in five different types of soil in nine localities in the State showed no significant differences between the varieties, but an increase in mineral content with size, the very small peas being conspicuously low in calcium.

The composition of tomatoes was found by the California station to be affected by the time of picking, locality, and variety. The total solids and total acidity of tomatoes grown in the cool coastal localities were higher than those of the same variety grown in the hot interior districts of the State. Greenhouse tomatoes ripened on the vine were found by the Wisconsin station to have a slightly lower content of vitamin C than field tomatoes ripened on the vine. At the Hawaii station analyses of various native vegetables showed that the Chinese heading cabbage contains much less calcium and iron than the corresponding nonheading cabbage and that Chinese spinach contains more calcium and less iron than the common variety.

Preliminary vitamin A determinations at the Pennsylvania station of spinach grown under various types of fertilizer treatment indicated that chlorotic spinach grown in soil of deficient manganese content contains less vitamin A than normal spinach. The Idaho station found young, growing potatoes to be richer in vitamin C than mature potatoes, both before and after storage.

That different parts of the same vegetable may contain unlike amounts of vitamins has often been demonstrated in the case of vitamin A and green vegetables, the outer greener leaves of lettuce and cabbage containing more of A than the inner white leaves. Significant differences were

demonstrated at the Iowa station in the vitamin B (B+G) content of the different structural parts of the carrot. The skin contained the most, followed in decreasing order by the flesh and the core.

Certain constituents of foods of animal origin may be altered by suitable feeding. The New York Cornell station found that feeding cod-liver oil to hens tended to raise the vitamin D content of the yolk of the eggs. At the Kentucky station, eggs produced in spring and summer and stored until winter proved richer in vitamin D than winter-produced eggs. The feeding of irradiated yeast to dairy cattle was found by the Wisconsin station to be a practical means of increasing the vitamin D content of milk. Better results were obtained with irradiated yeast than with cod-liver oil, partly because larger amounts of vitamin D could be administered and partly because irradiated yeast, unlike cod-liver oil, does not depress the fat content of the milk produced.

METABOLISM STUDIES

An investigation of the basal metabolism of young women was completed, by the Ohio station, with a total of 238 observations on 91 subjects from 14 to 18 years of age. Values for the average heat production were practically the same for all ages represented, approximately 1,350 calories per 24 hours. The heat production per kilogram of body weight decreased fairly regularly with age and, when age was disregarded, with increasing weight. Grouped as normal, overweight, and underweight, the averages for the overweight group were high for total heat production and heat production per centimeter of height and low for heat production per kilogram of body weight, and the opposite was true for the underweight group. The closest agreement for all groups was in the value for calories per square meter of body surface per hour. A tendency was noted toward slight seasonal variations in basal metabolism with a trend toward higher values in the spring months.

During an investigation on protein assimilation during lactation, the Wisconsin station found that in rats the act of suckling the young is followed by an increase in the concentration of urea in the blood of the mother regardless of the time elapsing after food had been eaten. Experiments on other lactating animals showed no such effect with cows, but a slight increase with rabbits and guinea pigs. A comparison of various sources of protein for lactation in rats showed cooked beef liver to be superior to casein, and egg albumin very unsatisfactory.

The investigation at the Utah station of the relationship of the physical curd character of milk to its digestibility and value in infant feeding was extended to comparative feeding tests with soft-curded and hard-curded milk, infants at the Salt Lake County hospital serving as subjects. The superiority of the soft-curded milk over the hard-curded milk was further substantiated, and wide interest in the subject was aroused in this country and abroad.

A new method of determining the rate of digestion of fats by counting with a dark field microscope the chylomicrons in drops of blood taken from the tip of the finger every hour during the digestive cycle was used at the New York Cornell station to determine the rate of digestion of butter, cream, and cod-liver oil. The rate of digestion of butter and cream when fed with bran was found to be practically as rapid as when fed alone. The rate of digestion of cod-liver oil was practically the same as for butter, but much slower with butter and cream from goat's milk.

The disputed question of the relation of the antineuritic vitamin B to carbohydrate metabolism was approached at the California station by determining the glucose tolerance of carefully paired rats on diets differing only in their content of vitamin B. In the animals suffering from only a slight deficiency in vitamin B the glucose tolerance curves did not vary greatly from the controls, but in those suffering from severe deficiency in this vitamin there was evidence of definite interference in carbohydrate metabolism. Continued investigation by the Arkansas station of the effect of vitamin deficiencies on carbohydrate metabolism, as determined by changes in the composition of the blood, revealed that the hyperglycemia often encountered in vitamin B deficiency in rats is in the apparent rather than the true sugar—i.e., in the reducing nonsugar—with no disturbance of true sugar until the final stage of the avitaminosis associated with prolonged fasting.

With copper accepted as an essential element for hemoglobin production, the manner of its functioning in the body is receiving attention. The Wisconsin station prepared pure hemoglobin from horse blood and from rat blood and tested it for copper. Although traces of copper were always found, the conclusion was that it could not be a part of the hemoglobin molecule, since

the more completely the hemoglobin was purified the smaller were the traces of copper. Moreover, if the copper present were a definite part of the molecule, the molecular weight of the hemoglobin would be 2,000,000 or 3,000,000 instead of the generally accepted weight of 66,000.

DIET AND HEALTH OF SCHOOL CHILDREN

The growing tendency to question height and weight standards for determining the nutritional status of children has been emphasized in several investigations under way or recently completed in various States. At the Texas station the question of the applicability of the customary growth standards to Mexican and negro children and even to white children of the State was approached through periodic growth measurements of more than 500 children of each of the three race groups. Preliminary work showed the importance of uniformity of experimental conditions. It is quite customary in weight records to have the children remove only their outer garments and shoes, but the clothing of different children was found to weigh from 15 ounces to 8 pounds 1 ounce, and that of individual children to vary from 1½ to 2 pounds. In another study at the same station, not yet completed, the diet scores for the white children were found to be quite similar to those of the Mexican children in the same region in spite of the fact that the Mexicans have a much less varied diet.

A study recently completed by the South Carolina station on the dietary habits and health of about 300 school children, 8, 9, and 10 years of age, in one county of the State also emphasized the belief that weight for height and age is unreliable as the sole method of detecting malnutrition. In the physical examination 41 per cent of the children were ranked as being in poor or very poor nutritional condition, 36 in fair, and 32 in good condition, while according to the Baldwin-Wood tables nearly half of those judged to be in poor or very poor nutritional condition would have fallen within 10 per cent of the satisfactory weight standards. The general condition of the teeth of the children in this study was considered good in 48, fair in 31, and poor in 21 per cent of the number. Over two-thirds of the children had carious 6-year molars so far as could be judged by the diet records, which represented only one or two days for each child. The greatest inadequacy in the diet was fruit, followed by milk and whole-grain cereals.

A more elaborate and extensive investigation of the nutritional status of school children in five representative counties in Florida, completed by the Florida station during the year, included physical examinations of over 3,000 children and dietary records for 2 or 3 day periods for 1,850 of these children. More than 45 per cent of the children had carious teeth, abnormal tonsils, and hookworm infestation, and more than 30 per cent had enlarged lymph glands, conjunctivitis, abnormal weight relations, and anemia. Heart defects were found in slightly more than 12 per cent of the children, chiefly among those in the first group. A definite relationship was noted between adequacy of the diet and dental condition and anemia, but no relationship between diet scores and height and weight records. Children suffering from hookworm infestation tended to be overweight and those with defective tonsils underweight. The final report of this investigation emphasizes that hookworm infestation and defective tonsils should be corrected and that until such corrections are made weight alone should not be used as the standard for nutrition.

A comprehensive survey by the Massachusetts station of the food services provided in the rural elementary schools of the State, where 16,000 pupils out of a total of 57,600 are obliged to remain in the school buildings for their midday meal, revealed the fact that in 567 of the 800 school buildings included in the survey there was no food service of any sort, and that in only 23 buildings were regular lunches served throughout the year. The number of absences from school due to digestive disorders was proportionally greater among the children who carried box lunches from home than among those who went home to lunch. That provision for some hot food for school lunches is not beyond the possibility of schools with very limited resources was shown in the report of this study by descriptions of some of the existing services. One of the simplest of these was located in a 1-room school building in the country. The children brought suitable food from home in glass Mason jars which were heated at noon in a wash boiler on a flat-top stove which heated the school room.

Sybil L. Smith.

RURAL HOME MANAGEMENT

In times of economic depression the question of efficient management of the

home is of paramount importance. This calls for wisdom in the management of time, in the selection and use of equipment to save time and expense, and in the management of the family finances so that proper standards of living may be maintained. Investigations along these lines are in progress at various experiment stations and a few of these were completed during the year.

Food consumption and expenditures.—A study at the Georgia station of food-consumption habits of 100 representative families in northern and a corresponding number in southern Georgia showed that the diets were probably adequate in calories, protein, and calcium, slightly deficient in phosphorus, and seriously deficient in iron. In food groups, the principal deficiences were in lean meat, eggs, dairy products, fruits, and vegetables. Increased production on the farms of foods for home consumption was recommended.

In a similar study at the Idaho station where more emphasis was laid on cost, differences in food selection in the winter and summer months were more apparent. Averaged for the different seasons, the consumption of fruits and vegetables compared favorably with accepted standards, but in the winter dietaries the consumption of leafy green vegetables was very low and of potatoes very high. Consumption of whole milk was low and of skim milk comparatively high. The cost of food consumed per adult male unit per day averaged 50 cents, with no appreciable difference between summer and winter dietaries. Of this, 49 per cent represented food furnished by the farm in the winter and 55 per cent in the summer.

The cost of adequate diets for farm and village families in New York State was studied by the New York Cornell station, using the analyses of day-by-day accounts for a 4-week period of all the food consumed by 100 or more families who were economically independent and in good health, but of widely varied economic status. The records were spread through a period of about 20 months, thus covering all seasons. After comparison of the diets with previously adopted standards of adequacy, the food costs of those diets meeting the standards of adequacy were calculated, and from these figures tables were prepared of adequate low-cost food budgets for all ages from a child a year old to an adult doing active work. For village families with no home-produced foods, the investigation showed that the cost of an adequate diet need not have exceeded 50 cents per man per day under existing prices. With wise planning and the use of home-produced milk, meat, eggs, fruits, and vegetables, it would be possible for the farm family to reduce expenditures for food far below this figure.

Time studies.—Studying the distribution of the time of farm home makers, the South Dakota station recorded an average expenditure of time for all forms of work of 66 hours and 10 minutes per week. These figures, as well as those for the distribution of work time among different tasks, were similar to corresponding figures noted in the previous report for several other States. The average time spent in purely home-making activities was 54 hours and 13 minutes per week. Nearly half of this time was devoted to feeding the family. The amount of farm work varied with the season but averaged 11 hours and 15 minutes per week. The leisure time averaged a little more than 3 hours a day. Of the entire number of 100 women, the 14 who were 50 years of age or older spent about 8 hours a week less than the average of the group on home-making tasks, practically the same amount of time on outside work, and about 5 hours more a week each on self care, including sleep, and on leisure activities.

In the figures given in the 1929 report for the distribution of the Rhode Island home maker's time, 4 hours and 30 minutes, which, through error, were stated as not accounted for, should have been accredited to paid work done by the home maker. In an investigation now in progress on the frequency and kind of such work in one county of Rhode Island, no less than 48 different ways of earning money were reported among 161 home makers. Piecework from neighboring mills provided a large amount of part-time home work. Among the unusual part-time occupations were retouching photographic plates, boarding dogs, and running a riding school. Information was being secured also on the home maker's use of help, either in the home or from outside utilities such as steam laundries, bakeries, and canneries, as well as on time and labor saving equipment.

The South Carolina station reported on the use of leisure in selected areas of the State, and the Nebraska station dealt particularly with seasonal work of farm women. The Nebraska report emphasized the importance of more careful planning of work over a long period so that the months in which farm

activities place an extra burden upon the home maker shall be left clear of everything that can be done at other seasons.

Efficiency studies of the household plant.—The strikingly uniform pattern of the distribution of the farm home maker's time, with the uniformly large proportion of time devoted to the activities involved in feeding the family, has aroused interest in possibilities of lessening this time by more efficient kitchen arrangement as well as by the introduction of improved equipment for household tasks. Studies on kitchen arrangement were inaugurated during the year at the Indiana, North Dakota, and Vermont stations. Attempts to measure definitely the cost of various tasks in terms of human energy were started at the Washington station. The principal findings in an Indiana station study on fuels used for cooking purposes in rural homes in the State were noted in the 1929 report. The Nebraska station, from its study on kerosene cook stoves, reported advantages and disadvantages in four types of kerosene burners, information which should be of help in the selection of kerosene cook stoves.

Rural family living.—Progress in this field, as measured by published reports, is necessarily slow, and none of the projects listed in the previous report as in progress has been completed. Progress reports on certain projects dealing with household expenditures indicate the general distribution among the various items, but the figures reported should be considered tentative until final reports appear. Household accounts kept by 34 rural home makers in Montana showed an average expenditure of $100 per month from February to September and of $135 a month during the late fall and winter. On dairy and truck farms about 25 per cent of this expenditure was for food, and on dry land or irrigated general farms about 35 per cent. About 14 per cent of the total expenditure was for clothing and 13 per cent for development. The monthly cost of operating the house varied from $16 to $25, while that of operating the family automobile was about $20.

A random selection of five native and five foreign-born families from the total number of families keeping accounts for a study at the Connecticut Storrs station showed that the expenditures of the foreign-born were higher than of the native for food, housing, clothing, and personal items.

Tentative figures for expenditures for clothing and household textiles in farm families were obtained by the Mississippi station from records kept by 55 families. The average family and farm earnings for the year were $1,452, the money expenditure for clothing $190, and that for household textiles $9. An average of 26 cents per family per week was spent for laundry, $3.80 per year for dry cleaning, and $3.19 per family per year for care and repair of shoes.

From detailed accounts of household expenditures of 70 Ohio farm families for 1927, the Ohio station found that the average cash income of the 70 families, averaging 4.7 persons each, was $2,099.40 and the average household expenditure $1,107.52. Of this, 20.5 per cent was for food, 16.3 for clothing, 12.7 for operating expense, 43.2 for indications of comfort, and 7.3 per cent for furniture, furnishings, and equipment. The items classified as indications of comfort included insurance, education, the automobile, care of the sick and death, church and benevolent contributions, dues, gifts, recreation, personal allowance, chewing gum, tobacco, and travel other than by automobile.

New projects approved during the year reflect interest in the possible economic contribution of farm home makers to the total family income through specific enterprises of their own, the economics of consumption as determined by methods of household buying, and the content, adequacy, and conditioning factors of family living, which can be determined only through cooperation of home economists with agricultural economists and rural sociologists. With the realization that the efficient management of the farm household depends to a great extent upon the farm home, a housing project has been undertaken at the Oregon station with the hope of determining standards of requirement for the farm home in relation to the activities within the home and the farm of which it is the center.

SYBIL L. SMITH.

TEXTILES AND CLOTHING

Research in this field, exclusive of studies on the economics of textiles and clothing more properly classified under home management, is now under way in seven States. A study of quantitative analytical chemical methods for textile fibers to determine the reliability of existing methods and possible improvements is in progress at the Iowa station.

The investigation on the protective value of certain clothing fabrics begun several years ago at the Kansas station

was extended to a comparison of the protective value of various fabrics against cold in still and moving air. The experiments were conducted in a calorimeter especially devised for the purpose and equipped with an air tunnel so that air could be blown over the fabric at definite velocities. The materials tested included Canton flannel (nap in and out), knit cotton underwear, infants' knit vests (wool and cotton), navy blue flannel, and gray astrakan (pile in and out). The relative ratings of the fabrics on the basis of increasing protective ratio were found to be the same in still and in moving air. When made into closely fitting covers, fabrics having a pile or nap afforded greater protection when the smooth surface was next the body.

A new constant-humidity conditioning room built at the Minnesota station was used in a study of fiber quality and physical qualities in relation to cost of staple wool materials.

The study of the durability of cotton fabrics as affected by home and commercial laundering was extended, at the Missouri station, to white cotton fabrics which were tested after 5, 15, and 30 launderings by home and commercial methods. The wear after 30 launderings, as measured by decreased tensile strength, was greater with commercial than home methods of laundering, and greater with the commercial methods used for badly soiled fabrics than for slightly soiled fabrics. Differences in shrinkage were also noted for the different methods of laundering.

The influence of laundering and exposure to light upon the color and durability of washable silks was studied at the Ohio station. Completed tests of pure-dye branded silks showed a decided fading as the result of both light exposure and laundering, some colors being affected more by light and others by laundering. The strengths of the silks, however, appeared to be affected more by light than by laundering.

Analysis of the fabrics, including linings, of 66 women's coats within a wide price range, was reported by the South Dakota station. While the higher-priced garments outranked the low-priced in most of the factors studied, the range in quality did not at all parallel that in price. A new study undertaken at this station dealt with the influence of various grades of wool on some of the physical properties of flannel. Known grades of wool were to be woven according to specifications by the same mill and the samples of the fabric from the different grades subjected to the customary tensile strength, abrasion, and bursting tests, durability tests, and shrinkage.

The influence of sunlight on the durability and color of cotton fabrics was tested by the Texas station in white and five colors of cotton fabrics of various weaves. In one of the colored fabrics a loss in color of 26 per cent occurred after 25 hours, 41 after 50, 48 after 75, and 52 per cent after 100 hours.

The habits of farm women relative to the purchase or home manufacture of clothing for the family were summarized by the Oklahoma station from a survey of about 500 families in the State. In comparison with a similar survey made throughout the country by the Bureau of Home Economics of the Department of Agriculture, house dresses, summer wash dresses, aprons, slips, and nightgowns were made by nearly the same percentages of the farm women in the two groups, but the Oklahoma women made more clothing for children and less for themselves than did those included in the larger study. Mail-order houses were patronized more or less by about two-thirds of the women.

SYBIL L. SMITH.

AGRICULTURAL ENGINEERING

Substantial progress was made by the experiment stations during the year in agricultural engineering investigations, as reflected in a strengthening and enlargement of research programs and the scientific value of the published output.

MECHANICAL EQUIPMENT

Investigations relating to mechanical farm equipment continued to be the feature of agricultural engineering research receiving primary emphasis at 33 of the experiment stations during the year.

Harvesting machinery.—Studies of combines and combining practices assumed considerable importance. Reports from the South Dakota, Ohio, Minnesota, Michigan, Missouri, and Montana stations indicated that combining, when properly done, saves considerable power, time, and labor. However, it has presented numerous specific difficulties, and much of the more recent station work has been aimed toward correcting some of the more important of these.

The South Dakota station, for example, developed the combining process so that wheat of low moisture content could be obtained. This station, and the Ohio and Missouri stations, demonstrated the utility and economy of the

windrowing process. The Ohio and Montana stations were especially successful in developing the windrower and pick-up devices, the former using a 16-foot windrower with a 12-foot combine, thereby reducing grain losses back of the cutter bar to a minimum. The Montana station showed that the windrow pick-up and the shock pick-up enable the harvesting of a larger acreage, and the Indiana station was able by this means to overcome the hazard of combining weak-strawed grains.

Grain losses in threshing were reduced by the Ohio station by such adjustments as increasing the cylinder speeds. The Minnesota and Missouri stations were able to reduce lodging losses in grain by proper adjustment and use of combining machinery, although it was necessary to reduce forward speeds considerably. The Montana station successfully developed the use of the supplemental header along cost-saving lines, especially where grain yields were low. The Michigan station developed a combine especially adapted to the harvesting and threshing of navy beans.

The practicability of harvesting corn with the combine has been demonstrated by several of the stations. The South Dakota station improved stationary mechanical corn-husking methods and the corresponding machinery along cost-saving lines. The optimum angle of the husking rolls in the bed was found to be from 18° to 22°, and it was shown to be desirable to adjust the angle to the moisture content in the husks of the snapped corn. The Ohio station was able to show a reduction in corn-harvesting costs by use of the mechanical corn picker although it wastes corn.

Crop drying equipment.—Artificial curing methods were studied by a number of stations, including those in Illinois, Wisconsin, Pennsylvania, Kansas, North Dakota, Mississippi, and Louisiana.

It appears that the future utility of the combine in most States depends largely upon the development of methods and equipment for satisfactorily drying combined grain which has not ripened uniformly or contains green weed seeds. This has led to studies of the basic requirements for the proper curing of grain. The North Dakota station in cooperation with the Department of Agriculture has demonstrated, for example, that wheat, oats, barley, rye, and buckwheat can be dried by forced draft with heated air, although considerable time is required in the process. Artificial drying by this method at temperatures of 120°, 140°, and 160° F. did not seem to affect the germination of the grain, nor were the milling and baking qualities of wheat impaired. On the other hand, the net increase in market value of wheat so treated, due to increase in test weight and decrease in moisture content, varied from 11 to 17 cents per bushel.

The Illinois station demonstrated that the moisture content of small grain and shelled corn can be reduced much more rapidly than that of ear corn by forced heated draft, and that for wheat there is one thickness of layer of the grain which gives the best results. The Wisconsin station perfected a bin method of drying seed corn.

Special attention was given during the year to the development of hay-curing methods and equipment at the Louisiana, Mississippi, Pennsylvania, Alabama, New Jersey, and Indiana stations, and some progress was reported. The Louisiana station successfully developed a revolving drum type of continuous hay drier having a capacity of 0.25 ton of dry hay per hour and a thermal efficiency of 50 per cent.

Further progress in the development of suitable breakpins for the hitches of tractor-drawn implements was reported by the California station, and the Montana station developed several new hitches for drawing as many as six implements in large-scale farming. The California station also found that the most satisfactory air cleaners for tractor-engine carburetors are the oily filter types, that filtration of the oil reduces engine wear appreciably, and that carbon rather than other solid foreign matter in the oil limits the useful life of such filters.

As a result of studies by the Alabama station of the factors influencing the traction of wheel tractors, it is becoming possible to design tractor wheels that will transform a maximum amount of the engine power into traction in soils having the lowest resistance to tractive impulses.

The development of the general-purpose tractor also proceeded along time and labor saving lines at several of the stations, notably those in Pennsylvania, Louisiana, Virginia, Iowa, Ohio, and Kansas. Progress was made at the Virginia station in securing greater stability of the general-purpose tractor for hilly farming by means of improved steering devices and weight distribution. The Pennsylvania station was able to adapt the general-purpose tractor specifically to potato production.

Some of the experiment stations have found that different conditions of carburetion, fuel consumption, and gaseous explosion are required in tractor engines

for optimum performance under varying conditions of agricultural service. Some of the studies conducted during the year suggest that a more thorough knowledge of liquid fuels may possibly lead to greater economy in power utilization as well as to more satisfactory and flexible performance of traction machinery. The North Dakota station, for example, demonstrated the utility of distillate as a tractor fuel for certain agricultural operations on account of its low price and the ability of most tractor engines to carburate it successfully.

Tillage machinery.—The Alabama station continued the study of those engineering properties of soil which govern the design of tillage implements. Marked progress was made in the development of a fundamentally sound design theory for tillage tools which will produce a desired degree of tilth with a minimum expenditure of draft power in overcoming the resistance of such soil factors as friction, shear, and cohesion.

The California station made considerable progress in studies of the dynamics of tillage machines, aiming to make them more adaptable to different agricultural operations. Draft studies by the Illinois station and by the Department of Agriculture in connection with the control of the European corn borer demonstrated the superior utility of large plows over small plows for covering cornstalks, and of plows equipped with properly adjusted jointers, covering wires, and extra large coulters. The use of a rear support wheel on the average plow was found to lower the draft as much as 7 per cent.

By use of hill planting, cross harrowing, and checkered tillage of cotton the Arkansas station was able practically to eliminate the hoe as a tool for killing grass and weeds and to render hand thinning unnecessary. The system of hill planting was found to facilitate the adaptation of larger-capacity tillage implements and to permit the cultivation of larger areas and the utilization of more power units per man.

Dairy machinery.—Investigations in dairy machinery assumed considerable importance at the stations during the year. The use of exhaust steam for cleaning and pasteurizing was developed along cost-saving lines by the California and Wisconsin stations, and also by the latter for heating milk for the separator and driers for casein. The use of solar heat for heating water for the dairy was a practical success at the Alabama station. The Oregon station established the practical value of precooling milk before refrigeration and of agitating the cooling water with particular reference to holding down the bacterial content.

Fertilizer and seeding machinery.—Studies on corn planter fertilizer attachments at the Wisconsin station were productive of basic information needed by the designer and manufacturer of fertilizer-distributing machinery. The problem of planting cotton and securing a stand in soils which form a thick crust after rainfall led the Mississippi and Alabama stations to make studies of the rupturing strength of soil crusts and of the vertical pushing power of individual growing cotton plants, which yielded valuable information as to the requirements of planting and the development of cotton-planting methods and machinery.

The Arkansas station demonstrated that hill planting of cotton on very fertile soil results in as high production as does row planting and permits considerable saving in time and labor in the other production operations. Grain drills with both fluted and internal double-feed types of force feeds were found by the North Dakota station to plant a uniform quantity of corn per acre. It also was found possible to plant corn with a beet drill as effectively as with a corn planter if special corn plates were used, thus developing multiple utility for the cheaper tool.

Feed processing machinery.—The value of ground feeds in the nutrition of livestock and the economic limits for fineness of grinding of feeds for various purposes have been studied by a number of stations. The Wisconsin and Kansas stations succeeded in developing the hammer type of feed mill to a very high point of efficiency and of economy in time, labor, and power consumption. An improved feeding mechanism, for example, has been developed by the Wisconsin station, which assures a constant and uniform movement of the unground grain into the mill. The Kansas station demonstrated the desirability of using knives for the first reduction in a hammer mill. When kept sharp they lowered the power cost, and produced a more uniform power requirement and a more uniform fineness of feed. Knives and hammers mounted on the same drive shaft saved power. A further reduction in feed-grinding cost was secured by the Pennsylvania station by grinding, elevating, mixing, and bagging feed in one operation.

Progress was made in lowering the cost of silage cutting and elevating at the Kansas and Wisconsin stations. The latter station found that the cutter elevates the cut corn by throwing instead of by blowing, and that, therefore,

cutters designed with fans producing the least air pressure require the least power for their operation. Shortening the fan wings resulted in increased mechanical efficiency and in a saving of from 5 to 15 per cent in power.

IRRIGATION AND DRAINAGE

Irrigation.—Station work on water resources for irrigation during the year dealt with both surface and underground waters and sought with considerable success to establish the principles governing their occurrence, amount, and movements. The Utah station, for example, secured information regarding the manner of occurrence and movement of mountain snow waters which aided materially in their conservation and control for irrigation use. The Idaho station derived a mathematical expression governing the flow of irrigation water in thin sheets in certain soils. The Arkansas station reported progress in determining the duty of water for rice, and the New Mexico, Arizona, Utah, Washington, and California stations materially advanced the practical knowledge of the irrigation of grain, hay, cotton, and root and fruit crops.

Drainage.—The New Mexico station established the influence of head on the movement of water in certain clay and clay loam soils. The California and Idaho stations made notable progress in developing the practice of drainage by pumping, and the Michigan station demonstrated the utility of mole drains for assisting ground water to flow toward tile drains when the latter are crosshatched by the former.

Land clearing.—Considerable progress was recorded at the Minnesota, Alabama, Wisconsin, Pennsylvania, and Michigan stations in determining the lifting and shattering power of different explosives and the relative efficiencies of several different mechanical clearing devices.

STRUCTURES

Poultry structures.—The Iowa and Nebraska stations found that large egg production and general good health seem to accompany small temperature fluctuations in poultry houses. The California, Idaho, and Missouri stations demonstrated the value of roof insulation in controlling temperatures in poultry houses and pointed out the practical importance of combining such insulation with well-controlled ventilation. The California station also found that in the brooding of chicks between 1 and 2 cubic feet of air per minute are required for each 100 chicks.

The utility of a hot-water heating system in maintaining uniform temperatures and humidities in insulated shed roof poultry houses was demontrated by the Indiana station, although it failed to maintain egg production at quite as high a level as in insulated but unheated houses. The value of open-front poultry houses with reference to egg production was established by the New York Cornell and North Dakota stations, and the Ohio station developed improved types of laying houses.

Dairy structures.—Investigations on heating, ventilation, and structural design of dairy barns were reported by several stations. The Kansas station showed the practical importance of using floor materials of low heat conductivity with reference to temperature control in the barn. The use of cork brick and wood blocks especially in stalls was demonstrated to be an ultimately economical procedure. The Idaho station showed, from investigations of scale models in the laboratory, that pressures below atmospheric are created in buildings under certain conditions, which may be more destructive than external wind forces.

Crop storages.—The utility and ultimate economy of artificial cooling of apple storages at certain seasons were demonstrated by the Massachusetts and Indiana stations. The Kansas station successfully developed storages for damp combined wheat, demonstrating the superior utility of well-ventilated steel bins over tight-walled steel bins for this purpose. The Illinois and Wisconsin stations continued work on the storage of soft corn, the former succeeding in lowering the cost per bushel for such storage.

Cost of farm structures.—The Arkansas station observed that the cost of farm buildings per cubic foot decreases as the volume of the structure increases, and that added height has a much smaller influence on total cost than either width or length. Typical larger farm structures such as barns, machinery sheds, storages, and the like, were found to cost approximately 6 cents per cubic foot under the conditions prevailing during the year.

Materials of construction.—The stations continued the search for cheaper and more durable materials of construction. This involved efforts to increase the durability of available materials and to develop the use of new materials.

The practical and economical use of adobe and rammed earth in farm-building construction was extended at the

California and North Dakota stations. In California sun-dried brick, rammed earth, and poured earth appear to be practical forms of earth for use in the walls of farm buildings.

Investigations were continued at the Missouri and Arkansas stations on the preservative treatment of fence posts, and at the Pennsylvania station on the preservative treatment of shingles. The tendency is to substitute laboratory tests of such materials for the long-time service tests which will simulate service conditions and produce results of practical utility in a relatively short time. Thus the preservative value of some relatively insoluble chemicals, such as copper borate, was established on account of their toxicity, permanency, and relatively low cost. The Missouri station showed that variety of wood is more important in a fence post than nature of preservative treatment, it being economically inadvisable to use wood which will not last naturally longer than 10 years.

RURAL ELECTRIFICATION

Poultry production.—The development of electrical brooding practices along lines of efficiency continued at the Indiana, Oregon, Idaho, and California stations. The superiority in current consumption of electric brooders of the underheat type over overhead heating types was demonstrated by the Indiana station, and the California station was able to eliminate considerable labor by the use of electric brooders as compared with coal-burning ones. Uniformity of temperature and ease of control were advantages also developed in electric brooders by this station.

The provision of drinking water of medium and uniform temperatures for poultry during cold weather has been found by several stations to favor egg production. The Idaho station, for example, successfully developed methods and electrical heating equipment whereby drinking water for poultry could be maintained at from 40° to 50° F. during cold periods, resulting in the drinking of 20 per cent more water by pullets than when the water was not heated. The advantage of thermostatic control of this equipment is that the temperature of the water never exceeds 50°.

Dairy production.—Rapid and marked progress was made by the stations in the adaptation of electricity to dairy requirements. The Oregon station developed the process of mechanical refrigeration of milk in a tank-type refrigerator to the point where it may be used satisfactorily and economically by the dairy farm where milk is marketed in 5 or 10 gallon cans. It was less expensive to cool milk below 50° F. in a tank-type cooler with mechanical refrigeration, using electricity at 3 cents per kilowatt-hour, than with ice at 0.5 cent per pound. The California station successfully developed both the wet and dry types of mechanical milk-cooling systems for dairy farms and reported that a milk-cooling plant will cost from 0.5 to 1 cent per gallon cooled, with electricity at 2 cents per kilowatt-hour.

Miscellaneous uses of electricity.—Progress was reported by the stations in the adaptation of electricity to other agricultural purposes, notably in the precooling of fresh fruits and vegetables for storage in refrigerator cars and warehouses by the California station, in the stimulation of vegetable crops by illumination by the Indiana station, and in the heating of hotbeds by the Washington station. The Nebraska station materially extended the practical and economical adaptation of small electric motors to different farm uses, and the Idaho station showed that the saving in time and labor and the improved distribution of labor obtained by use of the electric motor are more important than the saving in energy costs.

ROBERT W. TRULLINGER.

AGRICULTURAL ECONOMICS

The forward trend in agricultural economics was evident in notable increases both in the number of stations reporting on investigations and in the output of publications. Phases of farm management and marketing received most attention, but there were several contributions each on taxation, agricultural credit, land utilization, costs of production, and prices, and single publications on a number of other lines.

FARM MANAGMENT

Farm power studies.—The relative cost of tractors and horses as a source of farm power has been studied by a number of stations. Tractor work, in a study on 28 farms made by the Iowa station, was found to cost generally over $1 per hour where the tractor was used less than 300 hours during the year. The tractor seemed to be profitable when it permitted the number of horses per farm to be reduced by three, and consequently, was of doubtful economy on the 160-acre farm with about 100 acres in crop unless a general-purpose cultivating tractor could be used, thus displacing some of the four or five horses needed for the usual

crop operations. On the 240-acre farm the tractor generally was an economy. The acreage handled per horse increased from 12.5 with 80 acres of crops to 25 with 120 to 150 acres.

Tractors displaced an average of 2.1 work horses per farm on the farms studied by the Indiana station in 1919 to 1921, and 1925 to 1927, inclusive. In the latter period farms of about average size (174 crop acres) were operated with equal profit with horses only or with horses and a tractor. The horses averaged 819 hours work per year at a cost of 10.2 cents per hour and tractors 250 hours at an average cost of 92.3 cents per hour. Farmers using 5-horse or larger teams for plowing handled 30 per cent more acres of crop per man, had 26 per cent more production man work units per man, and obtained yields 8 per cent higher than those using smaller-sized teams.

The average cost per hour in 1926 of tractor work on 175 New York farms studied by the New York Cornell station was $1.16. The average number of hours used per year was 331.1 of which 71.4 hours was on belt work. Tractors displaced on an average 1.5 horses and 3.3 months of hired labor per farm, doing the work of 6.7 to 12.2 horses on heavy work and 2 to 4 horses on light work.

Farm and ranch management.—The percentage of young raised, fleece weights, death losses in the breeding herd, prices received, and rates of stocking with cattle, sheep, and goats were found to account for 73 per cent of the variations in income per section on ranches studied by the Texas station, the first three factors being responsible for approximately 50 per cent of the variations. The detailed budget of a 16.5-section ranch with its present organization of 33 cattle and 17 goats per section showed a probable net return of approximately $405 per section. The study indicated that with 15 cattle, 27 sheep, and 8 goats per section the return would have been $765, and with 15 cattle, 35 sheep, and 8 goats $950 per section.

Lack of long-time control of a sufficiently large area of grazing land was found by the North Dakota station probably to be the outstanding difficulty in ranch organization in western North Dakota. Increase in the number of cattle handled with a corresponding expansion in grazing area per ranch, together with greater production of feed crops through the adoption of better cultural methods, recognized rotation practices and crops adapted to the region, would have resulted, it is estimated, in ranch incomes of from $2,764 to $6,646 on a ranch typical for one area, as compared with the actual range of incomes of from $1,243 to $4,246 for the years 1926–1928, and of from $1,200 to $4,800, as compared with the actual range of from $1,023 to $2,271 on a ranch typical of another area.

Increase in the size of farms to permit use of 2-horse implements and additional production of corn, hay, cover crops, and livestock to supplement cotton growing and to give a longer employment season for labor were found by the Mississippi station to offer the best opportunities for increasing the income on farms studied in south-central Mississippi.

A number of farm-organization systems for 160 to 480 acre farms with estimated budgets were worked out by the South Dakota station to serve as guides in planning economic adjustments in southeastern South Dakota. The Kentucky station as a result of a similar study in the purchase region of Kentucky was able also to suggest farming systems for farms of different sizes from 60 to 300 acres that would give much better seasonal distribution of labor and higher returns.

Types of farming areas.—Realizing that adjustments of present farm organizations and practices, the determination of long-time farming systems, the interpretation of agricultural outlook data, and the investigation of specific agricultural economic problems can not be based on the political unit such as the State or county, a considerable number of the stations commenced type-of-farming area studies which are still in progress, and the results of such studies were published during the year by the Minnesota, Nebraska, Oklahoma, and Iowa stations.

COST OF PRODUCTION

Investigations of the costs of production and other economic aspects of different crops have continued to receive the attention of a considerable number of stations. Such studies of cherries, asparagus, and walnuts by the California station, of grapes by the Missouri station, of apples, apricots, cherries, peaches, and pears by the Washington station, and of pears and prunes by the Oregon station, as a whole, have shown that while consumption has greatly increased during the past decade, the plantings, many of which are either not yet bearing or not in full bearing, have also increased so rapidly that the competition between different sections is becoming greater and greater. In general, the studies showed that for the

immediate future at least the increases in demand will not keep pace with increased production, that lower rather than higher prices consequently may be expected, that new plantings except under particularly favorable conditions are not warranted at present, and that many of the present plantings will return a profit only by careful management both in production and marketing.

MARKETING

Quality as a factor in marketing.—The effect of quality on prices received for agricultural products was studied by several stations.

Sixty to eighty pound lambs in proper condition brought the top prices on the North Portland market, according to an Oregon station study. Only 34.5 per cent of the lambs received during the period of the study were in desirable condition; 47 per cent were too thin and 8.5 per cent too heavy and sold at an average of $1.85 and $2.75 per 100 pounds, respectively, below lambs in desirable condition. The Kentucky station found that 70 to 80 pound ewes and wether lambs brought the highest prices. The percentages of different grades of such lambs received on the markets studied during 1927–28 and the average differentials per 100 pounds in prices in 1928 from the prices for choice lambs, which constituted 18 per cent of the supply, were for prime 3 per cent and +45 cents; good (73 to 82 pounds), 36 per cent and −72 cents; good (below 73 pounds), 5 per cent and −$1.84; fair (73 to 82 pounds), 11 per cent and −$1.90; fair (below 73 pounds), 14 per cent and −$2.45; and common, 13 per cent and −$3.52.

Eggs sold to buying stations purchasing on grade, in a locality study by the Indiana station, brought on an average 2.37 cents more per dozen in 1926, 3.1 cents more in 1927, and 3.17 cents more in 1928 than they would have brought had they been sold at the flat prices paid by other stations in the locality.

Canning factories in Indiana buying tomatoes on grade increased from 9 in 1928 to 19 in 1929, the Indiana station reported, and the tonnage of tomatoes purchased was approximately 300 per cent greater. Growers selling to 17 of the factories in 1929 received from 5 cents to $2.62 more per ton than they would have received on the flat-rate basis. The cost of inspection varied from 12.7 to 80.3 cents per ton. Tests made by the station showed that No 1 tomatoes gave a better colored finished pulp and contained 8 per cent more solid matter than did No. 2 tomatoes. Factory tests showed that a load of matotoes containing 54.2 per cent United States No. 1 and 44.4 per cent No. 2 produced 18 No. 10 cans more per ton than a load containing 15.6 per cent No. 1 and 80.1 per cent No. 2.

Size of business as a factor in marketing.—The savings in costs and increases in profits resulting from increased volume of business were brought out clearly in a number of studies.

The cost of handling grain during the crop years of 1925, 1926, and 1927 in 28 farmers' elevators was found by the Montana station to range from 1.5 to 20.4 cents per bushel, averaging 5.6, 6.7, and 3.6 cents during the respective years. A close relation was found between the volume of grain handled during the year and the cost per bushel of handling, the cost being 18 cents where 20,000 bushels were handled, 6 cents for 100,000 bushels, 3.75 cents for 200,000 bushels, and 2 cents for 500,000 bushels.

Costs of plant operation and shipping costs of country milk plants could be reduced more than 6 cents per 100 pounds of milk handled and the hauling distance increased only 0.5 mile by eliminating 17 of the present 31 country plants in an area in central New York, according to a New York Cornell station study.

An increase of 1.5 times in the number of turnovers made of total investment was found to decrease fixed costs per dollar of sales 2 cents, in a study of 41 retail grain stores made by the New Hampshire station. Total costs decreased 1.7 cents per dollar of sales when inventory turnover increased three times. A study by the New York Cornell station showed that in the case of 60 retail feed stores owning their buildings, 35 per cent of the variations in total costs were related to variations in sales per employee, 15 per cent to inventory turnover, 8 per cent each to fixed property turnover and days' sales outstanding in receivables, and 5 per cent to distance from railroad siding.

Trucking livestock to market.—The rapid increase in the amount of livestock trucked to terminal markets has led to a number of studies in the Corn Belt States of the costs of trucking, trucking rates, losses by death and crippling, and other problems.

Trucking charges on hogs to the Indianapolis market in 1929 were found by the Indiana station to increase very uniformly from about 20.9 cents per 100 pounds for distances of from 18 to 22 miles to about 49 cents for hauls of from 88 to 92 miles. The percentage arriving by truck in 1929 was over 63

per cent, having increased from 4.5 per cent in 1913 and 27.3 per cent in 1920. Death losses of hogs during the period 1924-1927 were 0.88 per 1,000 head for truck shipments (most hauls less than 75 miles), as compared with 1.59 per 1,000 for railroad shipments (mostly 75 to 175 miles) during the four years ended June 30, 1926. The losses by crippling were 1.57 and 3.04 per 1,000 head, respectively.

The number of livestock trucked to Peoria, Ill., increased 7.5 per cent from 1928 to 1929, to East St. Louis 67.7 per cent, and to Chicago 30.7 per cent. The apparent saving on railroad shipments over truck shipments, at distances of over 45 miles, was found by the Illinois station to be 14 cents per 100 pounds to Peoria, 19 cents to East St. Louis, and 6 cents to Chicago on the basis of the December, 1928, trucking rates. The average saving per head of railroad over truck shipments to the three markets would have been 34.4 cents with the 1927 rates and 24 cents with the December, 1928, rates.

The truck has made it possible for marketing agencies to bring larger volumes of stock together and thus to secure better sorting and grading. The tendency, as found by the Ohio station, is for the marketing units now evolving to concentrate around points depending on the stock obtainable within a radius of from 10 to 20 miles. The growing practice of trucking direct to terminal markets, to slaughterers, or to fewer concentration points was evidenced by the fact that from 1923 to 1928 shipments from 30 railroad points in southwestern Ohio decreased more than did the livestock on the farms, and that 11 of the railroad stations, which in 1923 shipped 63.1 per cent of the total stock, in 1928 handled 83.1 per cent.

Trucking vegetables and fruits to market.— Approximately 14 per cent of the fruits and vegetable supply of New York City for the year August, 1928, to August, 1929, arrived by truck, according to a New Jersey station study. Farmers selling in farmers' markets trucked their produce, on an average, 29 miles. Fruits and vegetables received by trucks in the jobbing markets were hauled, on an average, 100 miles.

In Erie County, Pa., the Pennsylvania station found that grape shipments by truck brought the highest prices and that the highest returns per man hour of labor were made where more than 50 per cent of the grape crop was sold by truck.

Recent development of roads in southern Utah has so increased the opportunities for marketing truck and other produce in the mining camps and national parks of the neighboring sections of Utah and Nevada and in the Salt Lake City and other markets that it appears, according to a study made by the Utah station in Washington County, that that section can now profitably raise early spring and late fall vegetables, provided a uniform and dependable supply is produced and properly graded for marketing.

Pig survey reports.— Intentions to breed as reported by farmers in pig surveys fail of realization by 7 to 8 per cent for spring farrows and 9 to 10 per cent for fall farrows, according to an analysis of such reports made by the Missouri station. Comparison for the six years, 1923–1928, of the percentages of change in hog production in Missouri indicated by the pig surveys and the percentages of changes in marketing the following year (November to October) showed that with the exception of one year the pig surveys furnished fairly reliable indication of the future marketings.

TAXATION

Several contributions were made during the year that promise to assist State tax commissions and legislatures materially in changing present taxation systems so as to shift part of the heavy tax burden now borne by rural property, especially real estate, as a result of inequitable distribution between rural and other types of property, lack of uniformity in making assessments on the same kinds of property, and other defects in the present taxation systems, as well as from increased costs due to higher prices and the great increase of expenditures for governmental services, such as roads and schools.

Total rural taxes in Oregon increased 218 per cent and total urban taxes 217 per cent from 1910 to 1928. The average levies on rural taxable property were found by the Oregon station to have increased from 8.91 mills in 1911 to 15.46 mills in 1928 on the basis of selling value, and from 10.02 to 21.23 mills on the basis of full cash value. Urban levies increased from 14.71 to 28.82 mills on the sale-value basis and from 16.26 to 30.4 mills on the full cash-value basis. Assuming a 5 per cent investment basis, the 1928 tax levy increase over the pre-war average levies absorbed 13.7 per cent of the current rural and 23.83 per cent of the current urban land values on the sale-value basis and 16.6 and 26.2 per cent, respectively, on the full cash-value basis. On the market-value basis the percentages for different countries varied from 4.76 to

39.93 for rural lands and from 9.94 to 50.03 for urban lands. In the case of both rural and urban taxes, approximately 50 per cent of the increase was found to be due to the decrease in the value of the dollar.

Data from 1,093 rented farms in 33 counties and 889 properties in 33 cities and towns, studied by the Virginia station, showed that farm real-estate taxes in 1926 took from 15.9 to 32.8 per cent of the net rent, averaging 20 per cent, and that taxes on urban real estate took from 10.3 to 23.3 per cent, averaging 16 per cent. For 3.4 per cent of both the farm and urban properties taxes took less than 5 per cent of the net rent. They exceeded 50 per cent on 21.7 per cent of the farms and 3.7 per cent of the urban properties and were greater than the rent in the case of 11.7 per cent of the farms and 1.3 per cent of the town and city properties. Of the farms, 75.5 per cent were assessed at 50 per cent or less of their estimated true value and 4.1 per cent at more than 100 per cent. Of the town properties, 68.9 per cent were assessed at 50 per cent or less and 0.8 per cent at more than 100 per cent. The taxing of farm land according to capital value was found to result in a tendency for the percentage of net rent required for taxes to be high where such rent was low, and vice versa.

Farm taxes in terms of gross cash farm income in Ohio increased 60 per cent from 1913 to 1928, according to a study made by the Ohio station. From 1921 to 1928 property taxes and assessments equaled 20.57 per cent of the net cash, or 12.62 per cent of the total net agricultural income of Ohio farmers. Other taxes paid by farmers took an additional 2 per cent of the total net income. The property taxes on cash-rented farms took 17.08 per cent of the estimated net rent in 1900 and 38.44 per cent in 1928, varying in the latter year from 31.56 to 61.02 per cent in the four different districts of the State. The estimated ratio of taxes to real-estate value on cash-rented farms increased from 1.38 in 1923 to 1.81 in1928. On 595 owner-operated farms during the period 1914–1917, less than 5 per cent of the farm income was required for taxes on 17 per cent of the farms, less than 10 per cent on 67.7 per cent, less than 15 per cent on 84.3 per cent, and less than 50 per cent on 96 per cent of the farms. For the period 1924–1927, of 937 such farms, 3.6 per cent paid less than 5 per cent, 36.2 less than 10 per cent, 68.8 less than 15 per cent, and 97.3 per cent less than 50 per cent. In the case of over 700 farms studied, the average percentage of farm income required for taxes in 1926–27 decreased from 20 per cent for farms with incomes of from $500 to $999 to 7.88 per cent for farms with incomes of from $4,000 to $4,499. Assessed valuations on 1,599 farms ranged from less than 40 per cent of sales value for approximately 2.5 per cent of the farms to from 100 to over 175 per cent for approximately 18.9 per cent. The median valuation based on number of properties was approximately 86 per cent of the sale price.

The Massachusetts station found that from 1912 to 1926 public expenditures in Massachusetts increased 157.2 per cent. The increases for different governmental units were for the State 132.5 per cent, counties 183.5 per cent, towns under 5,000 in population 147.3 per cent, towns over 5,000 in population 193.6 per cent, and cities 157 per cent. The approximate increases for different purposes were for interest and debt 78 per cent, highways 221, education 242, charity, health, and correction 157, public service enterprises 129, and other general expenses 124 per cent. Property taxes constituted over 75 per cent of the total taxes collected and corporation taxes about 10 per cent. From 1910 to 1926 property taxes increased over 200 per cent, taxes on corporations including income and excise taxes 85, inheritance taxes over 300, and poll taxes nearly 31 per cent. The relative increase in property and real-estate taxes in farm towns was 40 per cent more than that in manufacturing towns and cities.

After studying the cost of maintenance of large (10 or more members) and of small (3 to 5 members) county boards in the United States, the New York Cornell station concluded that on the score of cost of maintenance small boards are decidedly to be preferred, that the average quality of the members of such boards is probably higher, that their responsibility to the voters is much more evident, and that they function with much more freedom than do the larger boards.

A detailed study of the costs of local government in Larimer County, Colo., made by the Colorado station indicated a number of opportunities for reducing costs in counties by improvements in the methods of handling records and accounts, introduction of systems of budgeting expenses, centralization of the purchase of supplies and equipment, reorganization and consolidation of related departments, a study of school indebtedness, elimination of bad features in the financing of education, the

levying of taxes for public improvements and services, such as roads and schools on larger territorial units, and control of the increase in the public debt.

Motor-vehicle travel from farms without the county plus all horse travel constituted only 5 per cent of the travel on 42 State highways, 13 per cent of that on 11 county and town roads, and 26 per cent of that on 57 dirt roads in New York, on which the New York Cornell station kept records. It was found that hard-surfaced roads increased the value of farm land about 20 per cent, and that the improvements of dirt roads at a cost of $10,000 per mile would be feasible for land valued at $50 or more per acre, provided such land paid only on the basis of the use made of the roads by farmers—i. e., $1,100 per mile.

FRED G. HARDEN.

RURAL SOCIOLOGY

Investigations in rural sociology reported by 14 stations covered a wide range of subjects. Twice as many publications were issued as in the preceding year. Although most of the inquiries were confined to limited areas, many of them may become units of studies broader in scope or in area covered and thus will contribute to findings having more general application.

The average number of contacts—i.e., hours of exposure to group influence—was found to be approximately 362 for country young people, 348 for country children, 333 for village young people, 307 for village children, 92 for village adults, and 38 for country adults in a study made by the Missouri station of an area populated by 1,297 persons, of whom 314 were in an incorporated village. Organizations produced 76.3 contacts per person, and unorganized activities 46 contacts. The costs of contacts produced by organizations varied from 1 cent to $1.23, the averages for different types being religious 40 cents, social 25 cents, recreational 25 cents, and educational 6 cents.

Using a participation index based on affiliations with, attendance at meetings of, contributions to, service on committee of, and office holding in organizations by persons over 10 years of age, which gave a rating of 1,000 for an individual having about average participation, the Wisconsin station found that 81 of 282 families in 12 selected rural-school districts had a zero index (no participation) and 201 had average indexes ranging from 40 to 9,675, the average being 1,159 and the median 933. Statistical analysis of the relation of the 40 or more factors considered to organization behavior showed that they were not responsible for more than 25 per cent of the influence of all factors. Those pertaining to educational and cultural facilities and activities showed the most significant positive relations. As a whole, distance to trading center, type of road, length of residence on present farm, church affiliation and attendance, size of family, age of members, and size of farm business showed little or no relation.

Although 65 per cent of the men gainfully employed in South Dakota were in agriculture and less than 8 per cent in commerce, a study of high schools by the station of that State showed that only 7.1 per cent offered vocational courses in agriculture and 36.8 per cent work in commerce. Home economics courses were taught in 24.6 per cent of the schools. Farm children constituted nearly 51 per cent of the total enrollment, but nearly 79 per cent of them lived outside of high-school districts and paid over $1,000,000 per year for tuition. Only 20 per cent of the high schools had enrollments of over 100 pupils, the average for medium-sized village and town schools being 76 and for small-village and open-country schools 23. County or State support of high schools was suggested as a means of reducing the tuition cost and at the same time making it possible for towns to expand their teaching program adequately to care for the vocational needs of both town and country pupils and thus reduce the apparent tendency of the academic high-school course to attract farm pupils away from the farm.

Sixteen per cent of the boys and 22 per cent of the girls over 16 years of age of 552 farm families studied by the Washington station had left the farm. Approximately 37 per cent of the boys left when under 20 years of age and 52 per cent between 20 and 30 years. The migration was largely due to economic reasons. Age of beginning full-time work, hours of chores per day, sharing in crops and planning work, hours worked per day, and the receiving of wages while under 21 years of age seemed to have been minor factors. The migration was not noticeably selective, and the study indicated that the farming communities can contribute a fairly large number of persons of superior ability to cities and still maintain a progressive and virile community, and that the social problem is not how to keep a large percentage of the young folks on

the farm but rather how to provide opportunities for growth and development of those remaining on the farms.

A study of 657 white families in Wake County, N. C., made by the North Carolina station, showed that 52 and 40 per cent, respectively, of the owners' and tenants' children over 14 years of age had left home. The movement began at about 18 years of age, and by the age of 30, 70 to 80 per cent of the sons and daughters had migrated. Establishment of homes of their own was the chief factor affecting the migration. Nearly 50 per cent of the sons who had left home were engaged in farming, and 50 per cent of the daughters were farmers' wives, indicating that there is a high degree of transmission of farming as a life work from parents to children. Children leaving farms tended to stay either in the open country or to go to the larger cities; 46 per cent of the sons and 48 per cent of the daughters were located in the open country; and 37 and 33 per cent, respectively, were in cities of over 10,000 population.

Income, proportion of total expenditures used for farm and investment, and proportion of expenditures used for the automobile were the factors found in Wake County by the North Carolina station to have the most influence on the proportion of expenditures used for family living in both white owner and tenant families. The automobile was the most important factor for tenants and third in importance for owners. The proportion of expenditures used for advancement increased only 3 per cent for owners and 2 per cent for tenants when income increased 100 per cent, indicating that family living was not being improved much in the county.

Other investigations reported on during the year included studies of the rural church and the rural negro church in Virginia by the Virginia station; costs and standard-of-living studies by the Missouri, Kentucky, and Ohio stations; rural-population studies by the Connecticut and New York Cornell stations; village service agencies and rural-relationship studies in definite areas of New York by the New York Cornell station; and a study of the use of leisure time in rural areas by the South Carolina station.

FRED G. HARDEN.

PUBLICATIONS OF THE STATIONS (1929-30)

The list given below includes 881 regular publications of the experiment stations received by the Office of Experiment Stations during the year ended June 30, 1930, classified as follows: Meteorology, 13; soils and fertilizers, 39; field crops, 98; horticulture, 102; forestry, 16; plant diseases, 45; entomology, 57; home economics, 34; animal production, 101; dairying, 36; diseases of livestock, 36; agricultural engineering, 41; economics and sociology, 125; and reports, periodicals, and regulatory and miscellaneous publications, 138. In addition to these regular reports and bulletins the office has a record of 1,422 articles relating to station work published during the year in 69 outside journals. Sixty-four articles contributed or collaborated in by 25 stations were published in the Journal of Agricultural Research.

The publications of the experiment stations show from year to year increasing evidence of care in preparation. Competent editorial assistance is being given a larger and more influential place in station organization, and there is a tendency toward closer coordination of all informational activities of the institutions with which the stations are associated, having as its object better dissemination and use of the results of station work.

METEOROLOGY

The climate of Ohio. W. A. Alexander and C. A. Patton. Ohio Sta. Bul. 445, 69 p., illus. 1929.

Meteorological observations. C. I. Gunness et al. Mass. Sta. Met. Buls. 486-497, 4 p. each. 1929-30.

SOILS—FERTILIZERS

SOILS

The so-called "build-up" and "break-down" o soil zeolites as influenced by reaction. P. S. Burgess. Ariz. Sta. Tech. Bul. 28, p. 101-135, illus 1929.

Comparisons of daytime and nighttime soil and air temperatures. A. Smith. Hilgardia [Calif. Sta.], vol. 4, no. 10, p. 241-272, illus. 1929.

A field test for available phosphorus in soils. R. H. Bray. Ill. Sta. Bul. 337, p. 590-602, illus. 1929.

Crop yields from Illinois experiment fields in 1929, together with a general summary for the rotation periods ending in 1929. F. C. Bauer. Ill. Sta. Bul. 347, p. 321-368, illus. 1930.

Caring for the fertility of Illinois soils. L. H. Smith and F. C. Bauer. Ill. Sta. Circ. 342, 20 p. 1929.

Test your soil for acidity. C. M. Linsley and F. C. Bauer. Ill. Sta. Circ. 346, 16 p., illus. 1929.

Douglas County soils. R. S. Smith, E. E. DeTurk, F. C. Bauer, and L. H. Smith. Ill. Sta. Soil Rpt. 43, 54 p., illus. 1929.

Coles County soils. R. S. Smith, E. E. DeTurk, F. C. Bauer, and L. H. Smith. Ill. Sta. Soil Rpt. 44, 61 p., illus. 1929.

Macon County soils. R. S. Smith, E. A. Norton, E. E. DeTurk, F. C. Bauer, and L. H. Smith. Ill. Sta. Soil Rpt. 45, 67 p., illus. 1929.

The management of peat and alkali soils in Iowa. W. H. Stevenson, P. E. Brown, and J. L. Boatman. Iowa Sta. Bul. 266, p. 82-100, illus. 1930.

Field experiments with fertilizers on some Iowa soils. W. H. Stevenson, P. E. Brown, L. W. Forman, H. R. Meldrum, A. J. Englehorn, and R. E. Bennett. Iowa Sta. Bul. 269, p. 163-202, illus. 1930.

Soil survey of Iowa.—Harrison County soils. W. H. Stevenson, P. E. Brown, et al. Iowa Sta. Soil Survey Rpt. 55, 72 p., illus. 1929.
Soil survey of Iowa.—Delaware County soils. W. H. Stevenson, P. E. Brown, et al. Iowa Sta. Soil Survey Rpt. 56, 72 p., illus. 1929.
Soil survey of Iowa.—Jones County soils. W. H. Stevenson, P. E. Brown, et al. Iowa Sta. Soil Survey Rpt. 57, 72 p., illus. 1929.
Soil survey of Iowa.—Fremont County soils. W. H. Stevenson, P. E. Brown, et al. Iowa Sta. Soil Survey Rpt. 58, 64 p., illus. 1929.
Soil survey of Iowa.—Cherokee County soils. W. H. Stevenson, P. E. Brown, et al. Iowa Sta. Soil Survey Rpt. 59, 64 p., illus. 1929.
Causes and effects of soil heaving. M. M. McCool and G. J. Bouyoucos. Mich. Sta. Spec. Bul. 192, 11 p., illus. 1929.
A test for water-soluble phosphorus: Studies on water-soluble phosphorus in field soils. C. H. Spurway. Mich. Sta. Tech. Bul. 101, 25 p. 1929.
The effect of the amount and nature of exchangeable cations on the structure of a colloidal clay. L. D. Baver. Mo. Sta. Research Bul. 129, 48 p., illus. 1929.
The soils of Missouri. M. F. Miller and H. H. Krusekopf. Mo. Sta. Bul. 264, 120 p., illus. 1929.
A fertilizer study on the brown soil of the Red Prairies. H. F. Murphy. Okla. Sta. Bul. 188, 5 p. 1929.
Fertility studies on Kirkland soil. H. F. Murphy. Okla. Sta. Bul. 189, 6 p. 1929.
The utilization of moisture on heavy soils of the southern Great Plains. H. H. Finnell. Okla. Sta. Bul. 190, 24 p. 1929.
Heavy plains soil moisture problems. H. H. Finnell. Okla. Sta. Bul. 193, 7 p. 1929.
The basicity of Texas soils. G. S. Fraps and E. C. Carlyle. Tex. Sta. Bul. 400, 20 p., illus. 1929.
Factors influencing runoff and soil erosion. A. B. Conner, R. E. Dickson, and D. Scoates. Tex. Sta. Bul. 411, 50 p., illus. 1930.
Success with sandy soils. A. R. Albert and A. R. Whitson. Wis. Sta. Bul. 416, 64 p., illus. 1930.
Soil problems of the Wheatland project. T. J. Dunnewald. Wyo. Sta. Bul. 168, 48 p., illus. 1929.

FERTILIZERS

Effects of synthetic nitrogen and concentrated fertilizers on cotton and sweet potatoes. J. J. Skinner, C. B. Williams, and H. B. Mann. N. C. Sta. Bul. 266, 40 p., illus. 1929.
A field test of different sources of phosphorus. C. F. Noll, F. D. Gardner, and C. J. Irvin. Pa. Sta. Bul. 252, 14 p., illus. 1930.
The comparative values of different phosphates. C. A. Mooers. Tenn. Sta. Bul. 141, 18 p., illus. 1929.
Comparison of soil liming materials. A. T. Wiancko, G. P. Walker, and S. D. Conner. Ind. Sta. Bul. 329, 23 p., illus. 1929
The influence of lime in vegetable growing. A. W. Blair and A. L. Prince. N. J. Stas. Bul. 498, 16 p., illus. 1930.
Choosing the right liming material. R. M. Salter. Ohio Sta. Spec. Circ. 24, 4 p. [1929.]
The effect of sulfur on yield of certain crops. E. B. Reynolds. Tex. Sta. Bul. 408, 24 p., illus. 1930.
Composting barnyard manure with sulphur and rock phosphate. W. G. Friedemann. Ga. Sta. Bul. 154, 14 p., illus. 1929.
Artificial manure from straw. R. C. Collison and H. J. Conn. N. Y. State Sta. Bul. 573, 17 p. 1929.
Bacteriological effects of green manure. Study No. III. C. F. Briscoe and H. H. Harned. Miss. Sta. Tech. Bul. 17, 11 p., illus. 1929.
Fertilizer rotation experiments at the Pee Dee Station. T. S. Buie. R. E. Currin, E. D. Kyzer, and J. D. Warner. S. C. Sta. Bul. 262, 38 p., illus. 1929.

FIELD CROPS

Experiments with alfalfa. M. Nelson. Ark. Sta. Bul. 242, 35 p., illus. 1929.
Alfalfa on the cut-over lands of northern Idaho. J. H. Christ. Idaho Sta. Bul. 169, 11 p., illus. 1930.
Alfalfa in western Oregon. H. A. Schoth and G. R. Hyslop. Oreg. Sta. Bul. 246, 38 p., illus. 1929.
Clover in the subirrigated meadows of the Sand Hills. E. M. Brouse. Nebr. Sta. Bul. 241, 12 p., illus. 1930.
The inheritance of germless seeds in maize. J. B. Wentz. Iowa Sta. Research Bul. 121, p. 345-379, illus. 1930.
Inheritance and linkage relations of virescent seedlings in maize. I. F. Phipps. N. Y. Cornell Sta. Mem. 125, 63 p. 1929.
The possibility of utilizing selfed strains in practical corn improvement. A. N. Hume. S. Dak. Sta. Bul. 245, 22 p. 1930.
Canada-Leaming corn. D. F. Jones and W. R. Singleton. Conn. State Sta. Bul. 310, p. 185-195, illus. 1930.
High yielding strains and varieties of corn for Iowa. H. D. Hughes. J. L. Robinson, and A. A. Bryan. Iowa Sta. Bul. 265, 80 p., illus. 1929.
High yielding strains and varieties of corn for Iowa. H. D. Hughes, J. L. Robinson, and A. A. Bryan. Iowa Sta. Bul. 265 (abridged), 24 p., illus. 1929.
Louisiana corn varieties. H. B. Brown. La. Stas. Bul. 210, 20 p. 1930.
Corn varieties in Texas, their regional and seasonal adaptation. P. C. Mangelsdorf. Tex. Sta. Bul. 397, 74 p., illus. 1929.
Silage corn varieties for Utah. G. Stewart and A. L. Wilson. Utah Sta. Bul. 211, 16 p., illus. 1929.
Better seed corn: Growing, selecting, storing, testing. R. J. Garber and M. M. Hoover. W. Va. Sta. Circ. 51, 15 p., illus. 1929.
Cotton breeding studies: I, Inheritance of fiber length. II, Heritable relationship of red plant color and leaf shape. J. O. Ware. Ark. Sta. Bul. 243, 38 p., illus. 1929.
Fruiting habit of the cotton plant. T. S. Buie. S. C. Sta. Bul. 261, 55 p., illus. 1929.
Results of cotton variety tests, 1926-1929. H. B. Tisdale and J. T. Williamson. Ala. Sta. Circ. 55, 8 p. 1930.
Cotton variety tests, 1929. G. A. Hale and H. K. Brabham. Ga. Sta. Circ. 87, 3 p. 1930.
Cotton varieties for Louisiana. A preliminary report. H. B. Brown. La. Stas. Bul. 207, 35 p., illus. 1930.
Cotton varieties, 1929. J. F. O'Kelly and W. W. Hull. Miss. Sta. Circ. 88, 7 p. 1929.
Cotton variety tests, 1929. W. B. Rogers and E. E. Hall. S. C. Sta. Circ. 40, 11 p. 1930.
Varieties of cotton for the Blackland region of central Texas. D. T. Killough, H. Dunlavy, and H. E. Rea. Tex. Sta. Bul. 399, 47 p. 1929.
Cotton variety experiments at Substation No. 2 Troup. W. S. Hotchkiss and P. R. Johnson. Tex. Sta. Bul. 406, 31 p. 1930.
Cotton fertilizer experiments in the Salt River Valley. G. H. Serviss and R. S. Hawkins. Ariz. Sta. Bul. 129, p. 317-337. 1929.
Cotton fertilizers and cultural methods. R. P. Bledsoe. Ga. Sta. Bul. 152, 37 p., illus. 1929.
Quality of cotton grown in Georgia. W. T. Fullilove and W. B. Lanham. Ga. Sta. Bul. 157, 28 p., illus. 1929.
Cotton fiber studies. R. C. Campbell. Ga. Sta. Bul. 158, 15 p., illus. 1929.
The composition of the cottonseed produced in New Mexico. C. W. Botkin. N. Mex. Sta. Bul. 175, 15 p. 1929.
A study of the root systems of some important sod-forming grasses. A. S. Laird. Fla. Sta. Bul. 211, 28 p., illus. 1930.
Experiments with turf grasses in New Jersey. H. B. Sprague and E. E. Evaul. N. J. Stas. Bul. 497, 55 p., illus. 1930.
The persistence of certain lawn grasses as affected by fertilization and competition. E. S. Garner and S. C. Damon. R. I. Sta. Bul. 217, 22 p., illus. 1929.
Experiments with legumes in Alabama. R. Y. Bailey, J. T. Williamson, and J. F. Duggar. Ala. Sta. Bul. 232, 45 p., illus. 1930.

Legumes as a source of available nitrogen in crop rotations. T. L. Lyon. N. Y. Cornell Sta. Bul. 500, 22 p., illus. 1930.

The effects of various legumes on the yield of corn. C. A. Mooers. Tenn. Sta. Bul. 142, 16 p., illus. 1930.

Legume bacteria with reference to light and longevity. W. A. Albrecht and L. M. Turk. Mo. Sta. Research Bul. 132, 19 p., illus. 1930.

Legume inoculation. W. A. Albrecht. Mo. Sta. Bul. 282, 12 p., illus. 1930.

The present status of legume inoculation in New York. H. J Conn. N. Y. State Sta. Circ. 114, 6 p. 1929.

The inoculation of non-legumes. L. W. Erdman and P. E. Brown. Iowa Sta. Bul. 262, p. 318-339, illus. 1929.

The inoculation of non-legumes. L. W. Erdman and P. E. Brown. Iowa Sta. Bul. 262 (abridged), 8 p., illus. 1929.

Korean lespedeza in Missouri. W. C. Etheridge, C. A. Helm, and B. M. King. Mo. Sta. Bul. 280, 14 p., illus. 1930.

Three new varieties of lespedeza. S. H. Essary. Tenn. Sta. Circ. 30, 3 p. 1930.

Varieties of oats for Illinois. G. H. Dungan and W. L. Burlison. Ill. Sta. Bul. 339, p. 23-50, illus. 1929.

Oat tests at the Michigan Experiment Station. E. E. Down, H. M. Brown, and F. H. Clark. Mich. Sta. Spec. Bul. 197, 12 p., illus. 1930.

Daily growth of the oat kernel and effect on germination of immaturity and controlled low temperatures. E. G. Booth. Minn. Sta. Tech. Bul. 62, 42 p., illus. 1929.

Columbia oats, a new variety for Missouri. L. J. Stadler and R. T. Kirkpatrick. Mo. Sta. Bul. 278, 12 p., illus. 1930.

Oat production and varieties for Wyoming. A. F. Vass and G. Hartman. Wyo. Sta. Bul. 170, 40 p., illus. 1930.

Permanent pastures can be improved. G. B. Mortimer and G. Richards. Wis. Sta. Bul. 414, 26 p., illus. 1930.

Effects of various treatments on the carbon dioxide and oxygen in dormant potato tubers. O. Smith. Hilgardia [Calif. Sta.], vol. 4, no. 11, p. 273-306, illus. 1929.

Ideal types for Colorado standard potato varieties. C. H. Metzger. Colo. Sta. Bul. 359, 23 p., illus. 1930.

Growing potatoes in Illinois. J. J. Pieper, W. L. Burlison, and W. P. Flint. Ill. Sta. Bul. 344, p. 242-284, illus. 1930.

Potato breeding methods: II, Selection in inbred lines. F. A. Krantz and A. E Hutchins. Minn. Sta. Tech. Bul. 58, 23 p., illus. 1929.

Tests with potato seed from various sources. R. A. Jehle and E. I. Oswald. Md. Sta. Bul. 317, p. 231-254, illus. 1929.

Certified Irish potato seed. Report of 1929 test. W. S. Anderson and L. E. Miles. Miss. Sta. Circ. 85, 5 p., illus. 1929.

Effect of cultural methods and maturity upon the seed value of eastern Nebraska potatoes. H. O. Werner. Nebr. Sta. Research Bul. 45, 45 p., illus. 1929.

Potatoes, production for seed. W. G. Couey. N. Dak. Sta. Circ. 37, 12 p., illus. 1929.

The value of certified Irish potato seed. J. A. McClintock. Tenn. Sta. Circ 25, 3 p. 1929.

Concentrated fertilizers for potatoes in Aroostook County. B. E. Brown and F. V. Owen. Me. Sta. Bul. 350, 44 p., illus. 1929.

Potato spraying and dusting experiments, 1926 to 1928. R. Bonde, D. Folsom, and E. R. Tobey. Me. Sta. Bul. 352, p. 97-140, illus. 1929.

Fertilizers for rice in Texas. E. B. Reynolds and R. H. Wyche. Tex. Sta. Bul. 398, 20 p. 1929.

Improvement of sagebrush range in Colorado. H. C. Hanson. Colo. Sta. Bul. 356, 12 p., illus. 1929.

Sweet sorghums for syrup and forage. C. K. McClelland. Ark. Sta. Bul. 241, 24 p., illus. 1929.

Improved methods of harvesting grain sorghum. J. P. Conrad and E. J. Stirniman. Calif. Sta. Bul. 477, 41 p., illus. 1929.

Sorghum crops on the high plains of Oklahoma. H. H. Finnell. Okla. Sta. Bul. 191. 30 p. 1929.

Illini soybeans. C. M. Woodworth. Ill. Sta. Bul. 335, p. 546-556, illus. 1929.

Soybean production in Kansas. J. W. Zahnley. Kans. Sta. Bul. 249, 31 p., illus. 1930.

Time of harvesting soybeans, in relation to soil improvement and protein content of the hay. R. E. Uhland. Mo. Sta. Bul. 279, 28 p., illus. 1930.

A classification of soybeans. W. C. Etheridge, C. A. Helm, and B. M. King. Mo. Sta. Research Bul. 131, 54 p., illus. 1929.

Varietal experiments with soybeans in New York. R. G. Wiggans. N. Y. Cornell Sta. Bul. 491, 19 p., illus. 1929.

Soybeans for Oklahoma. B. F. Kiltz. Okla. Sta. Circ. 77, 14 p. 1930.

Soybeans for silage and for hay. T. E. Odland. W. Va. Sta. Bul. 227, 24 p., illus. 1930.

Sugar cane test fields and fertilizer demonstrations. C. B. Gouaux. La. Stas. Bul. 203, 23 p. 1929.

Sugarcane variety work at the test fields. C. B. Gouaux. La. Stas. Bul. 211, 36 p. 1930.

Fertilizer studies and the production of sweet potatoes. F. W. Geise. Md. Sta. Bul. 311, 38+1 p., illus. 1929.

Truck crop investigations: Sweet potato fertilizers. H. H. Zimmerley. Va. Truck Sta. Bul. 66, p. 701-717, illus. 1929.

Soil reaction and liming as factors in tobacco production in Connecticut. M. F. Morgan, P. J. Anderson and H. Dorsey. Conn. State Sta. Bul. 306, p. 769-806, illus. 1929.

Results of tobacco experiments in Pennsylvania, 1922 to 1927. O. Olson and D. E. Haley. Pa. Sta. Bul. 240, 22 p., illus. 1929.

Tests of tobacco fertilizers comparing nitrogen, phosphorus and potassium from different fertilizer sources. T. B. Hutcheson and T. L. Copley. Va. Sta. Tech. Bul. 35, 10 p. 1929.

Rotation and the tobacco crop. J. Johnson and W. B. Ogden. Wis. Sta. Bul. 412, 24 p., illus. 1930.

Fertilizers for tobacco. J. Johnson and W. B. Ogden. Wis. Sta. Bul. 413, 31 p., illus. 1930.

Milling and baking qualities of pure lines of Arizona-grown wheat. W. E. Bryan and E. H. Pressley. Ariz. Sta. Tech. Bul. 27, p. 67-100, illus. 1929.

Wheat production in Kansas. S. C. Salmon and R. I. Throckmorton Kans. Sta. Bul. 248, 84 p., illus. 1929.

The influence of fallow on yield and protein content of wheat. E. Burke and R. M. Pinckney. Mont. Sta. Bul. 222, 19 p., illus. 1929.

Varietal resistance of spring wheats to bunt. W. E. Brentzel and R. W. Smith. N. Dak. Sta. Bul. 231, 12 p., illus. 1929.

Higher quality wheat, why and how? Ohio Sta. Spec. Circ. 25, 12 p. [1929.]

Varietal tests with wheat at the Sheridan Field Station. R. S. Towle. Wyo. Sta. Bul. 171, 11 p., illus. 1930.

Crop production at the Tucumcari Field Station. D. R. Burnham and H. J. Clemmer. N. Mex. Sta. Bul. 176, 42 p., illus. 1929.

Initial soil moisture and crop yield. H. H. Finnell. Okla. Sta. Bul. 192, 7 p. 1929.

Winter cover crop experiments. T. S. Buie. S. C. Sta. Circ. 37, 14 p., illus. 1929.

Field work, Ohio Agricultural Experiment Station. Ohio Sta. Spec. Circ. 27, 58 p., illus. 1930.

WEEDS

European bindweed. A. L. Bakke. Iowa Sta. Circ. 124, 12 p., illus. 1930.

Eradicating the bindweed with sodium chlorate. E. G. Schafer, O. C. Lee, and J. R. Neller. Wash. Col. Sta. Bul. 235, 16 p., illus. 1929.

Canada thistle and Russian knapweed and their control. C. F. Rogers. Colo. Sta. Bul. 348, 44 p., illus. 1928.

Organic food reserves in relation to the eradication of Canada thistles. F. A. Welton, V. H. Morris, and A. J. Hartzler. Ohio Sta. Bul. 441, 25 p., illus. 1929.

Marsh cress, a bad weed. L. H. Pammel, C. M. King, and A. Hayden. Iowa Sta. Circ. 120, 8 p., illus. 1929.
Wild garlic control in Illinois. J. J. Pieper and L. F. Rickey. Ill. Sta. Circ. 353, 15 p., illus. 1930.
Carbon disulfide for the eradication of perennial weeds. C. F. Rogers and I. Hatfied. Colo. Sta. Bul. 347, 23 p., illus. 1929.
Weeds in the vicinity of elevators. L. H. Pammel and C. M. King. Iowa Sta. Circ. 123, 4 p. 1930.
Weeds of New Jersey. J. G. Fiske. N. J. Stas. Circ. 219, 47 p., illus. 1929.

HORTICULTURE

FRUITS

Apple pollination investigations. A. E. Murneek W. W. Yocum, and E. N. McCubbin. Mo. Sta. Research Bul. 138, 36 p., illus. 1930.
Pollination and other factors affecting the set of fruit, with special reference to the apple. L. H. MacDaniels and A. J. Heinicke. N. Y. Cornell Sta. Bul. 497, 47 p., illus. 1929.
The effect of dusting-sulfur upon the germination of the pollen and the set of fruit of the apple. L. H. MacDaniels and J. R. Furr. N. Y. Cornell Sta. Bul. 499, 13 p., illus. 1930.
Cross-unfruitfulness in the apple. O. Einset. N. Y. State Sta. Tech. Bul. 159, 24 p. 1930.
Pruning apple trees in Illinois. R. S. Marsh. Ill. Sta. Circ. 349, 16 p., illus. 1929.
Defective graft unions in the apple and the pear. F. C. Bradford and B. G. Sitton. Mich. Sta. Tech. Bul. 99, 106 p., illus., 1929.
Some stock and scion observations on apple trees. R. H. Roberts. Wis. Sta. Research Bul. 94, 39 p., illus. 1929.
1930 spraying recommendations for apples. T. J. Headlee, W. H. Martin, and A. J. Farley. N. J. Stas. Circ. 220, 7 p. 1930.
Fruit varieties in Ohio: IV, Crab apples. C. W. Ellenwood. Ohio Sta. Bul. 434, 13 p., illus. 1929.
Varieties of apples for Pennsylvania. F. N. Fagan and R. H. Sudds. Pa. Sta. Bul. 253, 16 p., illus. 1930.
Five years' results with fertilizers in three Hudson River Valley apple orchards. H. B. Tukey and L. C. Anderson. N. Y. State Sta. Bul. 574, 31 p., illus. 1929.
Soil management experiments with the application of fertilizers in apple orchards. F. W. Hofmann. Va. Sta. Bul. 269, 35 p., illus. 1930.
Maintaining the productivity of cherry trees. V. R. Gardner. Mich. Sta. Spec. Bul. 195, 27 p., illus. 1930.
Investigations relating to the handling of sweet cherries, with special reference to chemical and physiological activities during ripening. H. Hartman and D. E. Bullis. Oreg. Sta. Bul. 247, 38 p., illus. 1929.
Sour cherry fruiting. R. H. Roberts. Wis. Sta. Bul. 415, 28 p., illus. 1930.
Citrus culture in Porto Rico. H. C. Henricksen. Porto Rico Sta. Bul. 33, 34 p., illus. 1930.
Mango culture in Hawaii. W. T. Pope. Hawaii Sta. Bul. 58, 27 p., illus. 1929.
Olive thinning and other means of increasing size of olives. H. E. Drobish. Calif. Sta. Bul. 490, 20 p., illus. 1930.
A study of the effect of commercial fertilizers on the performance of peach trees. J. R. Cooper and C. B. Wiggans. Ark. Sta. Bul. 239, 62 p., illus. 1929.
I, Irrigation experiments with peaches in California. A. H. Hendrickson and F. J. Veihmeyer. II, Canning quality of irrigated peaches. P. F. Nichols. Calif. Sta. Bul. 479, 63 p., illus. 1929.
Directions for grading and packing Illinois peaches. J. W. Lloyd. Ill. Sta. Circ. 343, 8 p. 1929.
Development and ripening of peaches as correlated with physical characteristics, chemical composition, and histological structure of the fruit flesh: III, Macrochemistry. G. T. Nightingale, R. M. Addoms, and M. A. Blake. N. J. Stas. Bul. 494, 16 p., illus. 1930.
1930 spray schedule for peaches. T. J. Headlee, W. H. Martin, and A. J Farley. N. J. Stas. Circ. 222, 4 p. 1930.
Maturity standards for harvesting Bartlett pears for eastern shipment. F. W. Allen. Calif. Sta. Bul. 470, 27 p., illus. 1929.
1930 spray schedule for pears. T. J. Headlee, W. H. Martin, and A. J. Farley. N. J. Stas. Circ. 223, 4 p. 1930.
Further investigations on the harvesting, storing, and ripening of pears from the Rogue River Valley. H. Hartman, F. C. Reimer, and R. K. Norris. Oreg. Sta. Bul. 254, 23 p., illus. 1929.
The Japanese persimmon in Florida. A. F. Camp and H. Mowry. Fla. Sta. Bul. 205, p. 527-562, illus. 1929.
1930 spray schedule for plums and cherries. T. J. Headlee, W. H. Martin, and A. J. Farley. N. J. Stas. Circ. 221, 4 p. 1930.
Plum variety test. A. B. Fite and F. Garcia. N. Mex. Sta. Bul. 174, 30 p., illus. 1929.
Progress report of prune storage and maturity studies. C. C. Vincent, L. Verner, and E. C. Blodgett. Idaho Sta. Bul. 167, 19 p., illus. 1929.
Studies of factors influencing separation of dried prunes into quality grades. E. H. Wiegand and D. E. Bullis. Oreg. Sta. Bul. 252, 47 p., illus. 1929.
Seedling fruit stocks. H. B. Tukey. N. Y. State Sta. Bul. 569, 34 p., illus. 1929.
Fruit pollination. A. E. Murneek. Mo. Sta. Bul. 283, 12 p., illus. 1930.
Pollination of fruit trees. R. Wellington, A. B. Stout, O. Einset, and L. M. Van Alstyne. N. Y. State Sta. Bul. 577, 54 p., illus. 1929.
A comparison of the transpiration rates of twenty-one deciduous fruit species. V. W. Kelley. Ill. Sta. Bul. 341, p. 95-116, illus. 1930.
Pruning fruit plants. R. J. Barnett. Kans. Sta. Circ. 153, 23 p., illus. 1929.
Pruning young fruit trees. R. E. Marshal, H. A. Cardinell, and H. D. Hootman. Mich. Sta. Circ. 127, 32 p., illus. 1929.
Planning, planting, and caring for the young orchard. F. M. Coe. Utah Sta. Circ. 83, 32 p., illus. 1930.
Building young deciduous fruit trees. F. M. Coe. Utah Sta. Circ. 84, 32 p., illus. 1930.
Sulphate of ammonia and nitrate of soda in a sod orchard. R. D. Anthony. Pa. Sta. Bul. 249, 24 p., illus. 1930.
New or noteworthy fruits, X. G. H. Howe. N. Y. State Sta. Bul. 578, 12 p., illus. 1929.
Varieties of fruits for West Virginia.—I, The tree fruits. H. E. Knowlton. W. Va. Sta. Bul. 222, 39 p. 1929.
The effect of dormant pruning on the carbohydrate metabolism of *Vitis vinifera*. A. J. Winkler. Hilgardia [Calif. Sta.], vol. 4, no. 6, p. 153-173, illus. 1929.
The use of sulfur dioxide in shipping grapes. H. E. Jacob. Calif. Sta. Bul. 471, 24 p., illus. 1929.
Berry thinning of grapes. A. J. Winkler. Calif. Sta. Bul. 492, 22 p., illus. 1930.
The young vineyard. N. L. Partridge. Mich. Sta. Circ. 124, 16 p., illus. 1929.
Cultural methods in the bearing vineyard. N. L. Partridge. Mich. Sta. Circ. 130, 19 p., illus. 1930.
Cane versus spur pruning for grapes. C. C. Wiggans. Nebr. Sta. Bul. 237, 30 p., illus. 1929.
1930 spray schedule for grapes. T. J. Headlee, W. H. Martin, and A. J. Farley. N. J. Stas. Circ. 224, 2 p. 1930.
Chemical studies of grape pigments.—V, The anthocyans in Ives grapes. R. L. Shriner and R. J. Anderson. N. Y. State Sta. Tech. Bul. 152, 11 p. 1929.
The propagation of the highbush blueberry. S. Johnston. Mich. Sta. Spec. Bul. 202, 22 p., illus. 1930.
The Young dewberry. J. G. Woodroof. Ga. Sta. Circ. 86, 6 p., illus. 1929.
The Van Fleet raspberry. J. A. McClintock. Tenn. Sta. Circ. 29, 4 p., illus. 1930.
Blackberries, raspberries and dewberries. H. G. Swartwout. Mo. Sta. Bul. 265, 31 p., illus. 1929.
Strawberries in Florida, culture, diseases and insects. A. N. Brooks, J. R. Watson, and H. Mowry. Fla. Sta. Bul. 204, p. 477-523, illus. 1929.
The strawberry in Ohio. J. S. Shoemaker. Ohio Sta. Bul. 444, 50 p., illus. 1929.

Washing fruit to remove spray residue in the Hudson Valley. E. V. Shear. N. Y. State Sta. Bul. 575, 34 p. 1929.
Spray residues. L. R. Streeter and S. W. Harman. N. Y. State Sta. Bul. 579, 12 p. 1929.
Sprays, their preparation and use. R. H. Robinson. Oreg. Sta. Bul. 259, 27 p., illus. 1930.
Protecting orchard crops from diseases and insects. C. R. Crosby, W. D. Mills, and W. E. Blauvelt. N. Y. Cornell Sta. Bul. 498, 80 p., illus. 1929.
Observations on the refrigeration of some Illinois fruits in transit. J. W. Lloyd and H. M. Newell. Ill. Sta. Bul. 334, p. 509–544, illus. 1929.

VEGETABLES

Field and sand culture experiments on fertilizing asparagus. T. H. White and V. R. Boswell. Md. Sta. Bul. 314, p. 147–161. 1929.
Studies of premature flower formation in wintered-over cabbage. V. R. Boswell. Md. Sta. Bul. 313, p. 69–145, illus. 1929.
A study of some factors affecting seed-stalk development in cabbage. J. C. Miller. N. Y. Cornell Sta. Bul. 488, 46 p., illus. 1929.
Quality in celery as related to structure. C. B. Sayre. Ill. Sta. Bul. 336, p. 558–588, illus. 1929.
The physiological effect of ethylene gas upon celery, tomatoes, and certain fruits. R. P. Hibbard. Mich. Sta. Tech. Bul. 104, 30 p., illus. 1930.
Premature seeding of celery. H. C. Thompson. N. Y. Cornell Sta. Bul. 480, 50 p., illus. 1929.
Species and varietal crosses in cucurbits. A. T. Erwin and E. S. Haber. Iowa Sta. Bul. 263, p. 343–372, illus. 1929.
Geneva, a greenhouse cucumber that develops fruit without pollination. L. R. Hawthorn and R. Wellington. N. Y. State Sta. Bul. 580, 11 p., illus. 1930.
Factors influencing yield and quality of peas, biophysical and biochemical studies. V. R. Boswell. Md. Sta. Bul. 306, p. 341–382. 1929.
The vegetables of New York: Vol. 1, part 1, Peas. U. P. Hedrick, F. H. Hall, L. R. Hawthorn, and A. Berger. N. Y. State Sta., vi+132 p., illus. 1928.
A study of spinach varieties with special reference to their canning qualities. H. B. Farley. Md. Sta. Bul. 307, p. 383–416, illus. 1929.
Variety studies of spinach. F. W. Geise and H. B. Farley. Md. Sta. Bul. 312, p. 39–67, illus. 1929.
Spinach for canning: The relation of physical and chemical properties to quality. F. W. Geise. Md. Sta. Bul. 320, p. 303–326, illus. 1930.
Truck crop investigations: Spinach fertilization with synthetic nitrogen salts. H. H. Zimmerley Va. Truck Sta. Bul. 63, p. 647–657, illus. 1928.
Cannery tomatoes: Results of three years' tests of varieties. F. W. Geise. Md. Sta. Bul. 318, p. 255–276, illus. 1929.
Nitrogen fertilizers for tomato production. J. L. Cooley, Jr. Miss. Sta. Bul. 273, 12 p., illus. 1930.
The effect of selection in the tomato. C. E. Myers and M. T. Lewis. Pa. Sta. Bul. 248, 20 p., illus. 1930.
Truck crop investigations: A comparison of wilt resistant tomatoes in Virginia. F. P. McWhorter and M. M. Parker. Va. Truck Sta. Bul. 69, p. 789–797, illus. 1929.
A preliminary study of the unicorn plants (Martyniaceae). G. P. Van Eseltine. N. Y. State Sta. Tech. Bul. 149, 41 p., illus. 1929.
The home vegetable garden. A. M. Binkley. Colo. Sta. Bul. 357, 45 p., illus. 1930.
Utilization and composition of oriental vegetables in Hawaii. H. L. Chung and J. C. Ripperton. Hawaii Sta. Bul. 60, 64 p., illus. 1929.
A select list of varieties of vegetables. H. L. Fackler. Tenn. Sta. Circ. 27, 4 p. 1929.
Fertilizing twenty-five kinds of vegetables. J. W. Lloyd and L. H. Strubinger. Ill. Sta. Bul. 346, p. 301–320, illus. 1930.
Amounts of fertilizer and manure required for maintenance of fertility for vegetable production. T. H. White and V. R. Boswell. Md. Sta. Bul. 309, p. 429–444. 1929.
The use of peat in the greenhouse. A. Laurie. Mich. Sta. Spec. Bul. 194, 28 p., illus. 1930.
Paper mulch for the vegetable garden, its effect on plant growth and on soil moisture, nitrates, and temperature. R. Magruder. Ohio Sta. Bul. 447, 60 p., illus. 1930.

ORNAMENTALS

Carnation culture. W. W. Wiggin. Ohio. Sta. Bul. 449, 28 p., illus. 1930.
The culture of greenhouse chrysanthemums. W. W. Wiggin. Ohio Sta. Bul. 439, 35 p., illus. 1929.
Recommended dates for application of standard hot water treatment to hardy narcissus. H. D. Locklin and G. A. Newton. West. Wash. Sta. Bul. 13-W, 31 p., illus. 1929.
Hardy roses for South Dakota. N. E. Hansen. S. Dak. Sta. Bul. 240, 48 p., illus. 1929.
Lawns in Florida. C. R. Enlow and W. E. Stokes. Fla. Sta. Bul. 209, 20 p., illus. 1929.
Better lawns. F. A. Welton and R. M. Salter. Ohio Sta. Spec. Circ. 18, 16 p., illus. 1929.
Landscape gardening in home beautification. W. Kennedy. Miss. Sta. Bul. 267, 41 p., illus. 1929.
House plants and their care. H. O. Yates, Jr. N. J. Stas. Circ. 217, 24 p., illus. 1929.
Truck crop investigations: Ornamental plants for the home grounds. M. M. Parker. Va. Truck Sta. Bul. 62, p. 633–644, illus. 1928.

NUTS

The Macadamia nut in Hawaii. W. T. Pope. Hawaii Sta. Bul. 59, 23 p., illus. 1929.
Report from the Natchez Branch Experiment Station on pecan work to December, 1929. S. J. Greer and W. T. Mallory. Miss. Sta. Bul. 275, 16 p., illus. 1929.

MISCELLANEOUS

Some effects of potassium deficiency on the histological structure and nitrogenous and carbohydrate constituents of plants. G. T. Nightingale, L. G. Schermerhorn, and W. R. Robbins. N. J. Stas. Bul. 499, 36 p., illus. 1930.
Horticulture at the Ohio Agricultural Experiment Station, Wooster, Ohio. Ohio Sta. Spec. Circ. 23, 38 p., illus. 1929.
Containers for plant growing. J. E. Knott and C. D. Jeffries. Pa. Sta. Bul. 244, 16 p., illus. 1929.
Experiments in plant heredity. N. E. Hansen. S. Dak. Sta. Bul. 237, 24 p. 1929.

FORESTRY

Forest possibilities of aspen lands in the Lake States. J. Kittredge, jr., and S. R. Gevorkiantz. Minn. Sta. Tech. Bul. 60, 84 p., illus. 1929.
Yield, stand and volume tables for Douglas fir in California. F. X. Schumacher. Calif. Sta. Bul. 491, 41 p., illus. 1930.
Yield of jack pine in the Lake States. A. E. Wackerman, R. Zon, and F. G. Wilson. Wis. Sta. Research Bul. 90, 23 p., illus. 1929.
Black locust in Pennsylvania. A. G. McIntyre. Pa. Sta. Bul. 236, 20 p., illus. 1929.
Oak forests of northern Michigan. J. Kittredge and A. K. Chittenden. Mich. Sta. Spec. Bul. 190, 47 p., illus. 1929.
Tables for determining the volume of black spruce. R. M. Brown. Minn. Sta. Tech. Bul. 57, 16 p., illus. 1929.
Studies in tolerance of New England forest trees.—IX, Rainfall and width of annual rings in Vermont forests. G. P. Burns. Vt. Sta. Bul. 298, 24 p., illus. 1929.
Drainage of swamps, and forest growth. R. Zon and J. L. Averell. Wis. Sta. Research Bul. 89, 22 p., illus. 1929.
Management of farm woodlands in Louisiana. G. D. Marckworth and R. Moore. La. Stas. Bul. 209, 21 p., illus. 1930.
The farm woodlot in Michigan. A. K. Chittenden and P. W. Robbins. Mich. Sta. Spec. Bul. 196, 28 p., illus. 1930.

The Christmas tree industry. E. Secrest. Ohio Sta. Forestry Pub. 6, 8 p., illus. [1930.]
Trees for Wyoming farmers and ranchmen. Wyo. Sta. Circ. 22, 4 p. 1929.
Trees for Wyoming farmers and ranchmen. Wyo. Sta. Circ. 23, 4 p. 1930.
Ohio forest fire manual. B. E. Leete. Ohio Sta. Forestry Pub. 3, 32 p. 1926.
Ohio forest fire manual. B. E. Leete. Ohio Sta. Forestry Pub. 5, 35 p. 1929.
Forest fire hazard as affected by weather conditions, forest type, and density of cover. J. A. Mitchell, Wis. Sta. Research Bul. 91, 26 p., illus. 1929.

PLANT DISEASES

FIELD CROPS

Alfalfa wilt in Nebraska. G. L. Peltier and J. H. Jensen. Nebr. Sta. Bul. 240, 35 p., illus. 1930.
The bacterial diseases of the bean, a comparative study. W. H. Burkholder. N. Y. Cornell Sta. Mem. 127, 88 p., illus. 1930.
Infection studies of *Diplodia zeae* (Schw.) Lev. and control of seedling blights of corn. W. P. Raleigh. Iowa Sta. Research Bul. 124, p. 93-121, illus. 1930.
Seed corn treatments at the North Platte Substation. L. L. Zook and N. E. Jodon. Nebr. Sta. Circ. 38, 4 p. 1930.
Plants susceptible or resistant to cotton root rot and their relation to control. J. J. Taubenhaus, B. F. Dana, and S. E. Wolff. Tex. Sta. Bul. 393, 30 p., illus. 1929.
Control of oat smut by seed treatment. S. G. Lehman and G. W. Fant. N. C. Sta. Bul. 268, 16 p., illus. 1929.
The causes of degeneration of Irish potatoes in Connecticut. B. A. Brown. Conn. Storrs Sta. Bul. 160, p. 327-380, illus. 1929.
Seed potato treatment tests for control of scab and Rhizoctonia. R. W. Goss and H. O. Werner. Nebr. Sta. Research Bul. 44, 42 p., illus. 1929.
The role of magnesium in the aging of plants. B. F. Lutman and N. L. Walbridge. Vt. Sta. Bul. 296, 48 p., illus. 1929.
The value of scabby potatoes. B. F. Lutman. Vt. Sta. Bul. 297, 16 p., illus. 1929.
Factors influencing the severity of the root rot troubles of sugar cane. H. H. Flor. La. Stas. Bul. 212, 40 p., illus. 1930.
Electrophoresis of the tobacco mosaic virus. W. N. Takahashi and T. E. Rawlins. Hilgardia [Calif. Sta.], vol. 4, no. 15, p. 441-463. 1930.
The overwintering of the tobacco mosaic virus. J. Johnson and W. B. Ogden. Wis. Sta. Research Bul. 95, 25 p. 1929.
Truck crop investigations: Fusarium wilt of tomato in Virginia. F. P. McWhorter and M. M. Parker. Va. Truck Sta. Bul. 64, p 661-674, illus. 1928.
Factors which modify the resistance of wheat to bunt, *Tilletia tritici*. F. N. Briggs. Hilgardia [Calif. Sta.], vol. 4, no. 7, p. 175-184. 1929.
Susceptibility of wheat varieties and hybrids to fusarial head blight in Minnesota. J. J. Christensen, E. C. Stakman, and F. R. Immer. Minn. Sta. Tech. Bul. 59, 24 p., illus. 1929.

FRUITS

Experiments with blister canker of apple trees. H. W. Anderson. Ill. Sta. Bul. 340, p. 55-90, illus. 1930.
The relation of woolly apple aphis to perennial canker infection with other notes on the disease. L. Childs. Oreg. Sta. Bul. 243, 31 p., illus. 1929.
Collar rot of apple trees. J. R. Magness. Wash. Col. Sta. Bul. 236, 19 p., illus. 1929.
Spraying materials and the control of apple scab. W. C. Dutton. Mich. Sta. Spec. Bul. 203, 32 p. 1930.
The occurrence and prevention of calyx injury in apples from the Hood River Valley. H. Hartman, L. Childs, and R. H. Robinson. Oreg. Sta. Bul. 242, 23 p., illus. 1929.
The life history of the fire blight pathogen, *Bacillus amylovorus*, as related to the means of overwintering and dissemination. H. R. Rosen. Ark. Sta. Bul. 244, 96 p., illus. 1929.
The effects of dessicating winds on citrus trees. H. S. Reed and E. T. Bartholomew. Calif. Sta. Bul. 484, 59 p., illus. 1930.

VEGETABLES

Studies of the black-rot or blight disease of cauliflower. E. E. Clayton. N. Y. State Sta. Bul. 576, 44 p., illus. 1929.
Corn diseases in Florida. A. H. Eddins. Fla. Sta. Bul. 210, 35 p., illus. 1930.
Angular leaf spot and fruit rot of cucumbers, caused by *Bacterium lachrymans* E. F. S. & Bry. G. F. Weber. Fla. Sta. Bul. 207, 32 p., illus. 1929.
Cucumber diseases in Florida. G. F. Weber. Fla. Sta. Bul. 208, 48 p., illus. 1929.
Seed treatment for the control of seed-borne diseases of melon, cucumber and squash. F. Van Haltern. Ga. Sta. Circ. 88, 8 p. 1930.
Inheritance of Fusarium wilt resistance in canning peas. B. L. Wade. Wis. Sta. Research Bul. 97, 32 p., illus. 1929.
Potato diseases in Montana. H. E. Morris and P. A. Young. Mont. Sta. Bul. 227, 51 p., illus. 1930.
Studies of the breeding of sugar beets for resistance to curly top. K. Esau. Hilgardia [Calif. Sta.], vol. 4, no. 14. p. 415-440, illus. 1930.
Diseases of sweet potatoes in Florida. G. F. Weber and E. West. Fla. Sta. Bul. 212, 40 p., illus. 1930.
A control for sweet potato wilt or stem rot. R. F. Poole. N. C. Sta. Bul. 273, 4 p., illus. 1930.
A control for sweet potato scurf. R. F. Poole. N. C. Sta. Bul. 274, 4 p., illus. 1930.
Some common tomato diseases and their control. S. H. Essary. Tenn. Sta. Circ. 31, 4 p. 1930.

TREES, ORNAMENTALS, AND MISCELLANEOUS

White pine blister rust control in Connecticut. J. E. Riley, jr. Conn. State Sta. Bul. 314, p. 451-477, illus. 1930.
The Rhizoctonia damping-off of conifers and its control by chemical treatment of the soil. J. S. Wiant. N. Y. Cornell Sta. Mem. 124, 64 p., illus. 1929.
Some common diseases of ornamental plants. E. L. LeClerg. Colo. Sta. Bul. 351, 31 p., illus. 1929.
Control of root-knot nematode in greenhouses. A. G. Newhall. Ohio Sta. Bul. 451, 60 p., illus. 1930.
The rusts of Pennsylvania. F. D. Kern, H. W. Thurston, jr., C. R. Orton, and J. F. Adams. Pa. Sta. Bul. 239, 53 p. 1929
Chlorosis, yellowing of plants, cause and control. F. B. Wann. Utah Sta. Circ. 85, 12 p., illus. 1930.

FUNGICIDES

Supplements for copper fungicides. E. B. Holland, C. O. Dunbar, and G. M. Gilligan. Mass. Sta. Bul. 252, p. 94-112. 1929.
The preparation and effectiveness of basic copper sulfate as a fungicide. E. B. Holland, C. O. Dunbar, G. M. Gilligan, and W. L. Doran. Mass. Sta. Bul. 254, p. 123-149. 1929.
The fineness of ground sulfur sold for dusting and spraying. L. R. Streeter and W. H. Rankin. N. Y. State Sta. Tech. Bul. 160, 16 p., illus. 1930.
Water soluble arsenic in spray material. H. C. Young. Ohio Sta. Bul. 448, 22 p., illus. 1930.

ENTOMOLOGY

INSECTS AFFECTING FIELD CROPS

Field studies of the physical ecology of the alfalfa weevil. H. L. Sweetman. Wyo. Sta. Bul. 167, 32 p., illus. 1929.

Studies on the morphology of the beet leafhopper, *Eutettix tenellus* (Baker). G. F. Knowlton. Utah Sta. Bul. 212, 24 p., illus. 1929.

Leafhopper injury to clover and alfalfa. H. H. Jewett. Ky. Sta. Bul. 293, p. 155–172, illus. 1929.

The clover-leaf caterpillar (*Olethreutes cespitana* Hübner) and the clover-leaf tyer (*Anchylopera angulifasciana* Zeller). L. P. Wehrle. N. Y. Cornell Sta. Bul. 489, 27 p., illus. 1929.

The clover-flower midge (*Dasyneura leguminicola* Lintner). L. P. Wehrle. N. Y. Cornell Sta. Bul. 481, 35 p., illus. 1929.

Biology and control of the southern corn rootworm. F. S. Arant. Ala. Sta. Bul. 230, 46 p., illus. 1929.

Corn-borer developments during 1929. W. P. Flint, G. H. Dungan, and A. L. Young. Ill. Sta. Circ. 350, 4 p., illus. 1930.

A study of hibernation of the corn earworm in Virginia. W. J. Phillips and G. W. Barber. Va. Sta. Tech. Bul. 40, 24 p., illus. 1929.

Boll weevil control by airplane dusting. F. L. Thomas, W. L. Owen, jr., J. C. Gaines, jr., and F. Sherman, III. Tex. Sta. Bul. 394, 40 p., illus., 1929.

Dusting sulphur for the control of cotton-leaf bugs. A. L. Hamner. Miss. Sta. Circ. 86, 4 p., illus. 1929.

The cotton-square borer. H. J. Reinhard. Tex. Sta. Bul. 401, 36 p., illus. 1929.

Some factors relating to the feeding habits of grasshoppers. G. S. Langford. Colo. Sta. Bul. 354, 53 p., illus. 1930.

Some effects of temperature and moisture upon *Melanoplus mexicanus mexicanus* Saussure and *Camnula pellucida* Scudder (Orthoptera). J. R. Parker. Mont. Sta. Bul. 223, 132 p., illus. 1930.

Hessian fly control in Indiana. W. H. Larrimer and C. M. Packard. Ind. Sta. Circ. 167, 12 p., illus. 1929.

Field studies of the pale western cutworm (*Porosagrotis orthogonia* Morr.). W. C. Cook. Mont. Sta. Bul. 225, 79 p., illus. 1930.

June beetles or white grubs in Michigan. R. H, Pettit. Mich. Sta. Circ. 132, 10 p.,illus. 1930.

Common pests of field and garden crops. R. H. Pettit. Mich. Sta. Spec. Bul. 183, 77 p., illus. 1929.

INSECTS AFFECTING VEGETABLES AND FRUITS

Ecological studies of the Mexican bean beetle. H.L. Sweetman and H. T. Fernald. Mass. Sta. Bul. 261, 32 p., illus. 1930.

The Mexican bean beetle, 1927-1928. C.O. Eddy and W.H. Clarke. S. C. Sta. Bul. 258, 41 p., illus. 1929.

Control of the Mexfcan bean beetle for 1930. C.O. Eddy and W. H. Clarke. S.C. Sta. Circ. 39, 16 p., illus. 1930.

How to prevent damage by the Mexican bean beetle. S. Marcovitch. Tenn. Sta. Circ. 28, 2 p. illus. 1930.

Truck crop investigations: The Mexican bean beetle in eastern Virginia. P. J. Chapman and G.E. Gould. Va. Truck Sta. Bul. 65, p. 677-697, illus. 1928.

Truck crop investigations: The Mexican bean beetle and its control. N. F. Howard and L. W. Brannon. Va. Truck Sta. Bul. 70, p. 801-808, illus. 1930.

The biology of the bean leaf-beetle. D. Isely. Ark. Sta. Bul. 248, 20 p., illus. 1930.

The bean leaf beetle. C.O. Eddy and W.C. Neetles. S. C. Sta. Bul. 265, 25 p., illus. 1930.

Control measures for cucumber beetles. H.C. Huckett. N. Y. State Sta. Tech. Bul. 148, 82 p. 1929.

The known predacious and parasitic enemies of the pea aphid in North America. C. L. Fluke. Wis. Sta. Research Bul. 93, 47 p., illus. 1929.

Truck crop investigations: Sweet potato sawfly. P. J. Chapman and G. E. Gould. Va. Truck Sta. Bul. 68, p. 769-786, illus. 1929.

The control of the apple curculio by hogs. B. B. Fulton. Iowa Sta. Circ. 117, 4 p., illus. 1929.

The cherry fruit-flies. R. H. Pettit and G. S. Tolles. Mich. Sta. Circ. 131, 11 p., illus. 1930.

A contribution to the biology and control of the green citrus aphid, *Aphis spiraecola* Patch. R. L. Miller. Fla. Sta. Bul. 203, p. 429-476, illus. 1929.

Cranberry false blossom and the blunt-nosed leafhopper. C. S. Beckwith and S. B. Hutton. N. J. Stas. Bul. 491, 16 p., illus. 1929.

The oriental peach moth in Connecticut. P. Garman. Conn. State Sta. Bul. 313, p. 395-451, illus. 1930.

The seasonal life history of the oriental fruit moth in New Jersey during 1924, 1925 and 1926, a summarized report. L. A. Stearns and A. Peterson. N. J. Stas. Bul. 455, 48 p., illus. 1928.

The oriental fruit moth. C. O. Eddy, M. H. Brunson, and W. H. Clarke. S. C. Sta. Circ. 38, 31 p., illus. 1930.

The Mediterranean and other fruit flies. H. J. Quayle. Calif. Sta. Circ. 315, 19 p., illus. 1929.

A preliminary account of the raspberry aphids. J. D. Winter. Minn. Sta. Tech. Bul. 61, 30 p., illus. 1929.

Responses to light of the bud moth and leaf roller. D. L. Collins and M. W. Nixon. N. Y. State Sta. Bul. 583, 32 p., illus. 1930.

Lime sulphur in relation to San Jose and oyster shell scales: Studies of contact insecticides, II. W. C. O'Kane and J. G. Conklin. N. H. Sta. Tech. Bul. 40, 15 p., illus. 1930.

The rosy aphid in relation to spray practices in 1929. P. J. Parrott and H. Glasgow. N. Y. State Sta. Bul. 582, 32 p., illus. 1930.

INSECTS AFFECTING MAN AND DOMESTIC ANIMALS

Mosquitoes of New Hampshire. P. R. Lowry. N. H. Sta. Bul. 243, 23 p., illus. 1929.

Effect of chemicals upon the behavior of mosquitoes. W. Rudolphs. N. J. Stas. Bul. 496, 24 p., illus. 1930.

Studies on the ox warble flies, *Hypoderma lineatum* and *Hypoderma bovis*, with special reference to economic importance and control. L. I. Case. Va. Sta. Tech. Bul. 39, 12 p., illus. 1929.

MISCELLANEOUS

The greenhouse centipede. H. K. Riley. Ind. Sta. Bul. 331, 14 p., illus. 1929.

The biology of the four-lined borer *Luperina stipata* (Morr.). G. C. Decker. Iowa Sta. Research Bul. 125, p. 125-164, illus. 1930.

Soft scales injurious to deciduous ornamentals. E. I. McDaniel. Mich. Sta. Circ. 133, 17 p., illus. 1930.

Wood-boring insects which attack furniture and buildings. E. I. McDaniel. Mich. Sta. Circ. 134, 12 p., illus. 1930.

The white pine weevil in New Hampshire. C. C. Plummer and A. E. Pillsbury. N. H. Sta. Bul. 247, 32 p., illus. 1929.

Notes on miscellaneous insects of Utah. H. J. Pack. Compiled by G. F. Knowlton. Utah Sta. Bul. 216, 32 p., illus. 1930.

Woodpeckers, nuthatches, and creepers of New Jersey. L. A. Hausman. N. J. Stas. Bul. 470, 48 p., illus. 1928.

INSECTICIDES

Insecticidal value of pyrethrum soaps. E. N. Cory and N. A. Eaton. Md. Sta. Bul. 308, p. 417-428. 1929.

A progress report on the testing of sulfonated oxidation products of petroleum for their insecticidal properties. J. L. Hoerner. Md. Sta. Bul. 310, p. 449-465. 1929.

Surface tension, surface activity, and wetting ability as factors in the performance of contact insecticides: Studies of contact insecticides, I. W. C. O'Kane, W. A. Westgate, L. C. Glover, and P. R. Lowry. N. H. Sta. Tech. Bul. 39, 44 p., illus. 1930.

Cryolite and barium fluosilicate, their use as insecticides. S. Marcovitch and W. W. Stanley. Tenn. Sta. Bul. 140, 19 p., illus. 1929.

BEEKEEPING

Apiary inspection, 1927–1929, and the foulbrood law. F. L. Thomas and C. E. Heard. Tex. Sta. Circ. 55, 15 p. 1930.

Sterilization of brood combs infected with American foulbrood. C. H. Gilbert. Wyo. Sta. Bul. 166, p. 151–171. 1929.

Mechanics of digestion of pollen by the adult honey bee and the relation of undigested parts to dysentery of bees. W. Whitcomb, jr., and H. F. Wilson. Wis. Sta. Research Bul. 92, 27 p., illus. 1929.

HOME ECONOMICS

FOODS AND HUMAN NUTRITION

The vitamin B content of vegetables. M. C. House, P. M. Nelson, and E. S. Haber. Iowa Sta. Research Bul. 120, p. 333–344, illus. 1930.

The energy and the protein content of foods regularly eaten in a college community. F. G. Benedict and A. G. Farr. N. H. Sta. Bul. 242, 60 p., illus. 1929.

The chemical composition and food value of Oregon dried prunes. J. S. Jones and D. E. Bullis. Oreg. Sta. Bul. 249, 10 p., illus. 1929.

Relative economy of the various cuts of pork. S. Bull and J. H. Longwell. Ill. Sta. Bul. 330, p. 334–347, illus. 1929.

Selection and use of pork cuts. A. M. Child. Minn. Sta. Bul. 254, 26 p., illus. 1929.

Utilization of surplus prunes. E. M. Mrak and W. V. Cruess. Calif. Sta. Bul. 483, 34 p., illus. 1929.

Drying cut fruits. P. F. Nichols and A. W. Christie. Calif. Sta. Bul. 485, 46 p., illus. 1930.

Fruit jellies: VI, The role of pectin: 2, The extraction of pectin from pectic materials. P. B. Myers and G. L. Baker. Del. Sta. Bul. 160, 64 p., illus. 1929.

Common storage of vegetables, a discussion of the factors involved. M. Benoy. Sundried vegetables. M. Benoy and G. Steininger. Okla. Sta. Circ. 75, 7 p. 1929.

Standardization of cherry and blackberry preserves and blackberry jelly. H. Cameron and R. B. Burns. W. Va. Sta. Bul. 234, 24 p., illus. 1930.

Blackberry jelly, blackberry jam, and cherry preserves. H. Cameron. W. Va. Sta. Circ. 55, 12 p. 1930.

A comparative investigation of certain film-forming fungi. M. A. Joslyn and W. V. Cruess. Hilgardia [Calif. Sta.], vol. 4, no. 9, p. 201–240, illus. 1929.

Bacteriological studies on sulfid spoilage of canned vegetables. C. H. Werkman. Iowa Sta. Research Bul. 117, p. 161–180, illus. 1929.

Control of spoilage in tomato products. C. S. Pederson and R. S. Breed. N. Y. State Sta. Bul. 570, 16 p. 1929.

The types of organisms found in spoiled tomato products. C. S. Pederson. N. Y. State Sta. Tech. Bul. 150, 46 p., illus. 1929.

The fermentation of glucose, fructose, and arabinose by organisms from spoiled tomato products. C. S. Pederson. N. Y. State Sta. Tech. Bul. 151, 22 p. 1929.

The number and type of bacteria in commercially prepared infant foods. G. J. and A. M. Hucker. N. Y. State Sta. Tech. Bul. 153, 28 p. 1929.

The sanitary control of commercially prepared infant foods. G. J. and A. M. Hucker. N. Y. State Sta. Tech. Bul. 154, 16 p. 1929.

Food service in Massachusetts rural elementary schools. E. Davies. Mass. Sta. Bul. 263, p. 51–69, illus. 1930.

Children of pre-school age in selected areas of South Carolina. M. E. Frayser. S. C. Sta. Bul. 260, 80 p., illus. 1929.

RURAL HOME MANAGEMENT

Food habits of Georgia rural people. S. J Mathews. Ga. Sta. Bul. 159, 31 p.. illus. 1929.

Food consumption and food expenditures in relation to standards of requirements and family income. M. W. Talbott. Idaho Sta. Bul. 165, 19 p. 1929.

Food consumption of farm families. H. McKay and M. A. Brown. Ohio Sta. Bul. 433, 34 p., illus. 1929.

Food habits of Utah farm families. A. P. Brown. Utah Sta. Bul. 213, 20 p. 1929.

Dietary studies of farm families in Albany and Lincoln Counties, Wyoming. E. J. McKittrick. Wyo. Sta. Bul. 165, p. 135–148. 1929.

Use of time by Oregon farm homemakers. M. Wilson. Oreg. Sta. Bul. 256, 71 p., illus. 1929.

Time factors in the business of homemaking in rural Rhode Island. M. Whittemore and B. Neil. R. I. Sta. Bul. 221, 35 p., illus. 1929.

The use of leisure in selected rural areas of South Carolina. M. E. Frayser. S. C. Sta. Bul. 263, 87 p., illus. 1930.

The present use of work time of farm homemakers. I. F. Arnquist and E. H. Roberts. Wash. Col. Sta. Bul. 234, 31 p., illus. 1929.

Water carried for household purposes on Nebraska farms. M. R. Clark and G. Gray. Nebr. Sta. Bul. 234, 22 p., illus. 1929.

The routine and seasonal work of Nebraska farm women. M. R. Clark and G. Gray. Nebr. Sta. Bul. 238, 39 p., illus. 1930.

Organization of the sewing center in the home. E. M. Cushman. N. Y. Cornell Sta. Bul. 492, 37 p., illus. 1929.

Comparative study of data on farm honsehold expenditures obtained by household accounts and by a survey. M. Muse and C. P. Brooks. Vt. Sta. Bul. 294, 32 p., illus. 1929.

TEXTILES

The textiles we buy and use. H. E. McCullough. Ill. Sta. Circ. 347, 94 p., illus. 1929.

ANIMAL PRODUCTION

ANIMAL NUTRITION AND FEEDING STUFFS

Simplified technique and apparatus for measuring energy requirments of cattle. E. G. Ritzman and F. G. Benedict. N. H. Sta. Bul. 240, 30 p., illus. 1929.

Surface areas of sheep. E. G. Ritzman and N. F. Colovos. N. H. Sta. Circ. 32, 8 p. 1930.

Supplementary energy-production coefficients of American feeding stuffs fed ruminants. G. S. Fraps. Tex. Sta. Bul. 402, 18 p. 1929.

Methods of balancing rations for dairy cows in digestibility trials with corn meal. C. W. Holdaway, W. B. Ellett, and J. F. Eheart. Va. Sta. Tech. Bul. 38, 10 p. 1929.

The nutritive value of blood-meal protein for growth. A. R. Winter. Ohio Sta. Bul. 436, 42 p., illus. 1929.

Effect of storage in finely divided feeds upon the stability of the D vitamin of cod-liver oil. L. C. Norris, G. F. Heuser, and H. S. Wilgus. N. Y. Cornell Sta. Mem. 126, 15 p., illus. 1929.

Studies in mineral nutrition. J. B. Lindsey and J. G. Archibald. Mass. Sta. Bul. 255, p. 151–166. 1929.

The results of a five year mineral feeding investigation with dairy cattle. O. E. Reed and C. F. Huffman. Mich. Sta. Tech. Bul. 105, 63 p., illus. 1930.

Results of a long time mineral feeding experiment with dairy cattle. C. F. Huffman and O. E. Reed. Mich. Sta. Circ. 129, 11 p., illus. 1930.

The effect of feeding different amounts of calcium and phosphorus upon the growth and development of dairy animals. H. O. Henderson and C. E. Weakley ,jr. W. Va. Sta. Bul. 231, 56 p., illus. 1930.

Corn silage feeding investigations: (Fifth paper), Relative feeding values of the dry matter of different types of silage corn ensiled at different stages of maturity. G. C. White and R. E. Johnson. Conn. Storrs Sta. Bul. 159, p. 315-323. 1929.
The Australian saltbush, *Atriplex semibaccata;* Its composition and digestibility. W. P. Headden. Colo. Sta. Bul. 345, 27 p. 1929. (An extension of Bul. 135.)
Pastures for spring and fall grazing in mountains of Colorado. H. C. Hanson. Colo. Sta. Bul. 360, 12 p., illus. 1930.
Intensive grassland management. R. C. Foley, E. J. Montague, and C. H. Parsons. Mass. Sta. Bul. 262, p. 35-50, illus. 1930.
Yield and composition of pasture grass. H. B. Ellenberger, J. A. Newlander, and C. H. Jones. Vt. Sta. Bul. 295, 68 p., illus. 1929.

HORSES AND MULES

Johnson grass hay versus timothy hay as a feed for horses and mules. J. C. Grimes and W. C. Taylor. Ala. Sta. Circ. 54, 8 p. 1930.
Mule feeding experiments. G. S. Templeton. Miss. Sta. Bul. 270, 38 p., illus. 1929.
The horse situation on New Hampshire farms. M. F. Abell. N. H. Sta. Circ. 31, 4 p., illus. 1929.

BEEF CATTLE

Steer feeding experiments in the Black Belt of Alabama. J. C. Grimes. Ala. Sta. Bul. 231, 18 p. 1930.
Utilization of wild oat hay for fattening yearling steers. H. R. Guilbert. Calif. Sta. Bul. 481, 21 p., illus. 1929.
Summer rations for fattening steers. R. R. Snapp and J. H. Knox. Ill. Sta. Bul. 328, p. 241-255, illus. 1929.
Cattle feeding: Winter steer feeding, 1925-26, 1926-27, 1927-28. J. H. Skinner and F. G. King. Ind. Sta. Bul. 330, 26 p., illus. 1929.
Cane molasses for finishing calves. C. C. Culbertson, J. M. Evvard, W. E. Hammond, and C. F. Bassett. Iowa Sta. Leaflet 27, 8 p. 1929.
Cattle feeding investigations, 1927-28. B. M. Anderson, C. W. McCampbell, and M. A. Alexander. Kans. Sta. Circ. 151, 20 p., illus. 1929.
Cattle feeding investigations, 1928-29. B. M. Anderson, C. W. McCampbell, and M. A. Alexander. Kans. Sta. Circ. 152, 14 p., illus. 1929.
Beef cattle production in Mississippi. G. S. Templeton. Miss. Sta. Bul. 268, 31 p., illus. 1929.
Retarded growth and mature size of beef steers. A. G. Hogan. Mo. Sta. Research Bul. 123, 52 p., illus. 1929.
The use of alfalfa pasture for fattening cattle. W. P. Snyder. Nebr. Sta. Bul. 239, 12 p. 1930.
The digestibility of cottonseed meal as a supplemental feed for range cattle in New Mexico. W. E. Watkins. N. Mex. Sta. Bul. 178, 42 p., illus. 1929.
The tale of the prize winners. J. H. Shepperd. N. Dak. Sta. Circ. 39, 8 p., illus. 1930.
Normal growth of range cattle. J. L. Lush, J. M. Jones, W. H. Dameron, and O. L. Carpenter. Tex. Sta. Bul. 409, 34 p., illus. 1930.
Beef slaughtering, cutting and curing. H. H. Smith. Utah Sta. Circ. 81, 16 p., illus. 1929.
The relative value of high-grade and low-grade calves marketed as two-year-old steers. E. A. Livesay W. Va. Sta. Bul. 225, 12 p., illus. 1929.

DAIRY CATTLE

Dairy herd improvement through the use of proved bulls. F. W. Atkeson, H. A. Mathiesen, and D. L. Fourt. Idaho Sta. Bul. 163, 23 p., illus. 1929.
Selecting the dairy sire. A. C. Ragsdale and W. Gifford. Mo. Sta. Bul. 274, 20 p., illus. 1929.
Care, feeding and management of the dairy sire A. C. Ragsdale and W. Gifford. Mo. Sta. Bul. 275, 14 p., illus. 1929.
A study of breeding records of dairy herds. C. H. Eckles. Minn. Sta. Bul. 258, 15 p. 1929.
Feeding and management of dairy calves in California. S. W. Mead. Calif. Sta. Bul. 478, 31 p., illus. 1929.
Raising dairy calves. E. Weaver, C. A. Matthews, and B. Oderkirk. Iowa Sta. Circ. 119, 32 p., illus. 1929.
Calf-feeding investigations.—I, Raising dairy calves on nurse cow, whole milk, remade skim milk, and calf meal. L. W. Ingham, D. Meade, and M. H. Berry. Md. Sta. Bul. 319, p. 275-302, illus. 1930.
Milk substitutes for calves. J. B. Lindsey and J. G. Archibald. Mass. Sta. Bul. 253, p. 115-122. 1929.
Self feeders in dairy calf feeding. T. M. Olson. S. Dak Sta. Bul. 236, 16 p., illus. 1929.
Wintering dairy heifers by means of the self-feeder. H. O. Henderson and E. L. Anthony. W. Va. Sta. Bul. 232, 20 p., illus. 1930.
Ground versus unground soybean hay for dairy cows. L. W. Ingham and D. Meade. Md. Sta. Bul. 316, p. 219-229. 1929.
Feeding dairy cattle. A. C. Ragsdale. Mo. Sta. Bul. 281, 40 p., illus. 1930.
Simplified methods of calculating dairy rations. F. B. Headley. Nev. Sta. Bul. 116, 23 p., illus. 1929.

SHEEP AND GOATS

Some comparisons of methods of fattening western lambs. W. G. Kammlade. Ill. Sta. Bul. 338, 20 p. 1929.
Cottonseed meal with various roughages as fattening rations for lambs. R. F. Cox. N. Mex. Sta. Bul. 179, 24 p., illus. 1929.
Lamb feeding experiments. D. S. Bell. Ohio Sta. Spec. Circ. 16, 8 p. [1929.]
Lamb slaughtering and cutting. H. H. Smith. Utah Sta. Circ. 82, 16 p., illus. 1929.
The medullated wool fiber. J. F. Wilson. Hilgardia [Calif. Sta.], vol. 4, no. 5, p. 135-152, illus. 1929.
Karakul sheep. J. L. Lush, J. M. Jones, and R. E. Dickson. Tex. Sta. Bul. 405, 20 p., illus. 1930.
A manual for sheep club members. W. G. Kammlade and E. I. Pilchard. Ill. Sta. Circ. 351, 48 p., illus. 1930.
The inheritance of cryptorchidism in goats. J. L. Lush, J. M. Jones, and W. H. Dameron. Tex. Sta. Bul. 407, 23 p., illus. 1930.

SWINE

Type in swine as related to rate and economy of gain and quality of pork. S. Bull and W. E. Carroll. Ill. Sta. Circ. 345, 14 p., illus. 1929.
The northern pig, its habits, breeding and management. J. H. Shepperd. N. Dak Sta. Bul. 230, 123 p., illus. 1929.
Growth and reproduction in swine. F. F. McKenzie. Mo. Sta. Research Bul. 118, 67 p., illus. 1928.
Growth studies with swine. J. H. Longwell, H. O. Henderson, and W. M. Insko, jr. W. Va. Sta. Bul. 230, 24 p., illus. 1930.
A new feeding method and standards for fattening young swine. J. M. Evvard. Iowa Sta. Research Bul. 118, p. 181-304, illus. 1929.
Hogging off corn. W. E. J. Edwards. Mich. Sta. Spec. Bul. 200, 17 p., illus. 1930.
Soybeans and soybean oil meal in swine rations. L. A. Weaver. Mo. Sta. Bul. 266, 20 p., illus. 1929.
Swine feeding experiments with fall pigs. W. L. Robison and L. E. Thatcher. Ohio Sta. Spec. Circ. 17, 14 p. [1929.]
Swine feeding experiments. W. L. Robison. Ohio Sta. Spec. Circ. 26, 16 p. [1930.]
Pasture crops for swine. M. A. McCarty and M. F. Grimes. Pa. Sta. Bul. 254, 12 p., illus. 1930.
Cottonseed meal as a feed for hogs. F. Hale. Tex. Sta. Bul. 410, 32 p., illus. 1930.

Cost of raising pigs to weaning age. E. H. Hostetler, R. E. Nance, and J. E. Foster. N. C. Sta. Bul. 272, 12 p., illus. 1930.
Domestic slaughtering, cutting, and curing of pork. H. H. Smith. Utah Sta. Circ. 80, 20 p., illus. 1929.
Swine publications and associations. A. L. Anderson and J. M. Evvard. Iowa Sta. Circ. 122, 8 p., illus. 1930.

POULTRY

Studies on the plumage of the silver spangled fowl. L. C. Dunn and W. Landauer. Conn. Storrs Sta. Bul. 163, p. 29–82, illus. 1930.
The selection of breeding sires. W. C. Thompson. N. J. Stas. Hints to Poultrymen, vol. 18, no. 3, 4 p., illus. 1929.
Baby chicks. C. S. Platt. N. J. Stas. Hints to Poultrymen, vol. 18, no. 6, 4 p., illus. 1930.
Factors influencing egg production: I, The influence of maturity upon egg production in S. C. White Leghorns. C. W. Knox. Iowa Sta. Research Bul. 119, p. 309–332, illus. 1930.
Inbreeding in relation to egg production. F. A. Hays. Mass. Sta. Bul. 258, p. 255–302, illus. 1929.
The economic significance of egg weights. W. C. Thompson. N. J. Stas. Hints to Poultrymen, vol. 17, no. 9, 4 p. 1929.
Some inherited causes of low egg production. C. S. Platt. N. J. Stas. Hints to Poultrymen, vol. 17, no. 12, 4 p. 1929.
Report of the New Jersey egg-laying contests, 1928–29. J. W. Goodman. N. J. Stas. Hints to Poultrymen, vol. 18, no. 2, 4 p., illus. 1929.
Egg production for profit. L. M. Black. N. J. Stas. Hints to Poultrymen, vol. 18, no. 4, 4 p. 1930.
The New Jersey egg-laying contests. J. W. Goodman. N. J. Stas. Hints to Poultrymen, vol. 18, no. 8, 4 p. 1930.
Studies on the inheritence of egg-weight.—II, The effect of selection on egg-weight. N. F. Waters and J. C. Weldin R. I. Sta. Bul. 218, 26 p., illus. 1929.
A study of the time factor in egg production. H. Atwood. W. Va. Sta. Bul. 223, 11 p. 1929.
The relationship between the number and weight of eggs and body weight of Leghorn fowls during the first three years of production. H. Atwood. and T. B. Clark. W. Va. Sta. Bul. 233, 20 p., illus. 1930.
New Mexico egg storage studies, Part I. A. L. Walker, L. N. Berry, and E. E. Anderson. N. Mex. Sta. Bul. 177, 47 p., illus. 1929.
Artificial incubation at high altitudes. F. J. Kohn. Wyo. Sta. Bul. 169, 20 p. 1930.
Rate of growth in Rhode Island Reds. F. A. Hays and R. Sanborn. Mass. Sta. Bul. 259, p. 303–321. 1929.
Limitations as to sunlight requirements of hens. W. P. Wheeler. N. Y. State Sta. Bul. 572, 14 p. 1929.
Rearing chicks in confinement. H. H. Alp. Ill. Sta. Circ. 352, 4 p., illus. 1930.
Keeping chickens in confinement. D. C. Kennard and R. M. Bethke. Ohio Sta. Bul. 437, 22 p., illus. 1929.
Managing confined fowls. H. C. Knandel, E. W. Callenbach, and P. H Margolf. Pa. Sta. Bul. 246, 14 p., illus. 1930.
Feeding trials with laying hens.—I, Varying amounts of meat scrap; II, Dull-gray and white, shiny limestone; III, All-mash and grain and mash. J. H. Martin and W. M. Insko, Jr. Ky. Sta. Bul. 294, p. 173–203, illus. 1929.
The relation of inadequate rations to the weights of the internal organs of chicks. A. G. Hogan, C. L. Shrewsbury, and H. L. Kempster. Mo. Sta. Research Bul. 122, 23 p., illus. 1929.
The effect of inadequate rations on the composition of the blood and of the bone of chicks. A. G. Hogan, C. L. Shrewsbury, and H. L. Kempster. Mo. Sta. Research Bul. 124, 17 p. 1929.
Causes of differences in poultry profits. R. L. Mighell and F. H. Branch. Mass. Sta. Bul. 251, p. 73–91, illus. 1929.
Effect of systems of feeding and management on flock returns. D. S. Bell. Ohio Sta. Spec. Circ. 21, 10 p., illus. [1929.]
Feed consumption and costs in raising turkeys. E. M. Funk and P. H. Margolf. Pa. Sta. Bul. 250, 11 p., illus. 1930.
Results of poultry feeding experiments. G. L. Stevenson. S. Dak. Sta. Bul. 242, 8 p. 1929.
New Jersey poultry rations. C. S. Platt. N. J. Stas. Hints to Poultrymen vol. 17, no. 11, 4 p. 1929.
Washington chick rations. J. S. Carver, W. D. Buchanan, and M. W. Miller. Wash. Col. Sta. Pop. Bul. 146, 18 p., illus. 1929.
Washington chick rations. M. W. Miller, W. D. Buchanan, and J. S. Carver. West Wash. Sta. Bul. 15-W, 18 p., illus. 1930. (Reprint of Wash. Col. Sta. Pop. Bul. 146, above.)
A summer shelter for New Jersey pullets. L. M. Black. N. J. Stas. Hints to Poultrymen, vol. 17, no. 10, 4 p., illus. 1929.
The new adaptable poultry house. D. C. Kennard. Ohio Sta. Spec. Circ. 15, 8 p., illus. 1929.

MISCELLANEOUS

Rabbits. W. C. Thompson. N. J. Stas. [Hints to Poultrymen], vol. 18, no. 7, 4 p., illus. 1930.

DAIRYING

A statistical study of the size of fat globules in cows' milk. C. W. Turner and A. C. Haskell. Mo. Sta. Research Bul. 130, 11 p., illus. 1929.
Bacterial counts in sanitary milk control. R. S. Breed. N. Y. State Sta. Bul. 567, 25 p., illus. 1929.
The sanitary significance of leucocytes in milk. R. S. Breed. N. Y. State Sta. Bul. 568, 14 p., illus. 1929.
Electric cooling of milk on the farm. J. C. Marquardt and A. C. Dahlberg. N. Y. State Sta. Bul. 581, 20 p., illus. 1930.
The production of high quality milk: I, Cooling the electric brine cooler with cold-air storage versus ice and water. H. B. Ellenberger. Vt. Sta. Bul. 300, 12 p., illus. 1929.
Cream line studies of market milk. G. M. Trout. W. Va. Sta. Bul. 229, 20 p., illus. 1930.
I, The microscopic appearance of unpasteurized market milk and cream. R. S. Breed. N. Y. State Sta. Bul. 566, 28 p., illus. 1929.
The effect of different pasteurization temperatures on several of the physical properties of milk. W. H. E. Reid. Mo. Sta. Research Bul. 126, 12 p., illus. 1929.
Bacteria that survive and grow during the pasteurization of milk and their relation to bacterial counts. P. S. Prickett and R. S. Breed. N. Y. State Sta. Bul. 571, 25 p., illus. 1929.
VI, The control of bacteria that grow during pasteurization. M. W. Yale. N. Y. State Sta. Tech. Bul. 156, 25 p. 1929.
VII, The udder as a possible source of thermophilic bacteria. P. A. Hansen. N. Y. State Sta. Tech. Bul. 158, 14 p. 1929.
The Grindrod Impact Sterilizer. G. J. and A. M. Hucker. N. Y. State Sta. Tech. Bul. 155, 31 p., illus. 1929.
Producing quality cream. W. H. Martin and W. J. Caulfield. Kans. Sta. Circ. 154, 18 p., illus., 1929.
The creaming of raw and pasteurized milk. A. C. Dahlberg and J. C. Marquardt. N. Y. State Sta. Tech. Bul. 157, 80 p., illus. 1929.
The manufacturing process for commercial sour cream. F. J. Doan and C. D. Dahle. Pa. Sta. Bul. 233, 15 p. 1929.
The removal of the bitter flavor from "bitterweed" cream. M. B. MacDonald and A. Glaser. Tenn. Sta. Circ. 26, 2 p. 1929.
The keeping quality of stored dairy products.—I, Metallic flavor in frozen cream. H. B. Ellenberger and H. L. White. II, Comparative keeping quality of cream, butter, and butter oil. J. A. Newlander and H. B. Ellenberger. Vt. Sta. Bul. 299, 16 p. 1929.

Factor influencing the flavor of butter.—I, The effect of various starter cultures on the flavor of butter. C. C. Walts. II, The effect of various neutralizers on the flavor of butter. C. C. Walts and M. S. Libbert. Ark. Sta. Bul. 249, 26 p. 1930.

Proteolysis by *Streptococcus lactis* with special reference to butter cultures and butter. B. W. Hammer and V. H. Patil. Iowa Sta. Research Bul. 123, p. 57–91. 1930.

Keeping qualities of butter.—VI, Experiments on the production of metallic flavor in butter and milk; VII, The microbic flora of off-flavored butter. G. L. A. Ruehle. Mich. Sta. Tech. Bul. 102, 46 p. 1930.

The butter industry of Oregon: A study of factors relating to the quality of butter. E. S. Larrabee and G. Wilster. Oreg. Sta. Bul. 258, 30 p., illus. 1929.

A new method for estimating the true fat content of buttermilk. W. E. Petersen and E. O. Herreid. Minn. Sta. Tech. Bul. 63, 16 p. 1929.

Factors influencing properties of fermented reconstructed milk. W. H. E. Reid and F. F. Welch. Mo. Sta. Research Bul. 135, 14 p. 1930.

Enzyme activity of ice-cream improvers. P. H. Tracy and H. A. Ruehe. Ill. Sta. Bul. 333, p. 482-508, illus. 1929.

Use of honey in ice-cream manufacture. P. H. Tracy, H. A. Ruehe, and F. P. Sanmann. Ill. Sta. Bul. 345, p. 285-300, illus. 1930.

The effect of homogenization at different pressures on the physical properties of an ice cream mixture and the resulting ice cream. W. H. E. Reid and G. R. Skinner. Mo. Sta. Research Bul. 127, 24 p., illus. 1929.

The effect of processing ice cream mixtures at different pressures when the milk solids not fat content is varied. W. H. E. Reid and E. R. Garrison. Mo. Sta. Research Bul. 128, 41 p., illus. 1929.

The effect of different homogenization processes on the physical properties of an ice cream mixture and the resulting ice cream when the percentage of fat is varied and the solids not fat remain constant. W. H. E. Reid and L. B. Russell. Mo. Sta. Research Bul. 134, 40 p., illus. 1930.

Viscosity in ice cream mixes. H. F. DePew. N. H. Sta. Tech. Bul. 38, 16 p., illus. 1928.

A comparison of aging periods for ice cream mixes. J. C. Hening. N. Y. State Sta. Tech. Bul. 161, 21 p., illus. 1930.

The effect of aging the mix on the freezing time, overrun, and quality of ice cream. C. D. Dahle, J. I. Keith, and A. D. McCullough. Pa. Sta. Bul. 247, 20 p., illus. 1930.

Farm dairying. J. B. Fitch. Kans. Sta. Circ. 148, 31 p., illus. 1929.

Practices on Rhode Island dairy farms. J. L. Tennant. R. I. Sta. Bul. 219, 41 p., illus. 1929.

Studies in Vermont dairy farming.—V, Cabot-Marshfield area. E. W. Bell. Vt. Sta. Bul. 304, 29 p., illus. 1929.

Factory tests for dairy products. D. R. Theophilus. Idaho Sta. Circ. 53, 8 p. 1929.

Use exhaust steam in dairy plants. M. J. Buck and H. C. Jackson. Wis. Sta. Bul. 411, 14 p., illus. 1930.

DISEASES OF LIVESTOCK

Studies on the control of Bang's abortion disease of cattle. C. C. Palmer. Del. Sta. Bul. 163, 55 p., illus. 1929.

Studies on porcine infectious abortion. R. Graham, I. B. Boughton, and E. A. Tunnicliff. Ill. Sta. Bul. 343, p. 177-240, illus. 1930.

The collection of blood samples for the agglutination test in bovine infectious abortion. R. L. Hectorne and R. Graham. Ill. Sta. Circ. 348, 8 p., illus. 1929.

The differentiation of the species of the genus Brucella. I. F. Huddleson. Mich. Sta. Tech. Bul. 100, 16 p., illus. 1929.

The pathogenicity of the species of the genus Brucella for the fowl. I. F. Huddleson and M. W. Emmel. Mich. Sta. Tech. Bul. 103, 30 p., illus. 1929.

Undulant fever in man and abortion disease in cattle. E. T. Hallman and E. L. Anthony. Mich. Sta. Circ. 128, 4 p. 1929.

Infectious abortion of cattle. H. Welch. Mont. Sta. Circ. 137, 14 p. 1930.

Bang's disease (bovine infectious abortion) and abortion in other farm livestock. A. F. Schalk. N. Dak. Sta. Circ. 40, 31 p., illus. 1930.

Undulant fever in man and its relationship to abortion disease in cattle and swine. A. F. Schalk. N. Dak. Sta. Circ. 41, 11 p. 1930.

Anemia in suckling pigs. E. B. Hart et al. Wis. Sta. Bul. 409, 14 p., illus. 1929.

The production of sterile anthrax antigens. S. J. Schilling. Ark. Sta. Bul. 238, 27 p. 1929.

Blackhead in turkeys, surgical control by cecal abligation. A. J. Durant. Mo. Sta. Research Bul. 133, 32 p., illus. 1930.

Studies on the pathology and physiology of the cecal pouches of turkeys.—II, The utilization of food by turkeys with abligated ceca. J. E. Hunter, A. J. Durant, and A. G. Hogan. Mo. Sta. Research Bul. 136, 12 p. 1930.

The control of fowl pox in poultry. E. M. Gildow, G. S. Schilling, P. Moore, and C. E. Lampman. Idaho Sta. Bul. 168, 19 p., illus. 1929.

The cutaneous vaccine for fowl pox. N. J. Pyle. Mass. Sta. Bul. 257, p. 235-254, illus. 1929.

Vaccination for the prevention of fowl pox. E. M. Gildow and C. A. Bottorff. N. H. Sta. Circ. 30, 12 p., illus. 1929.

Fowl pox. F. R. Beaudette. N. J. Stas. Hints to Poultrymen, vol. 17, no. 8, 4 p. 1929.

Congenital loco in chicks. F. L. Knowlton. Oreg. Sta. Bul. 253, 15 p., illus. 1929.

Manson's eyeworm of poultry. D. A. Sanders. Fla. Sta. Bul. 206, p. 567–585, illus. 1929.

Studies on infectious mastitis with special reference to streptococci. First report. G. D. Brigham, J. G. McAlpine, and E. O. Anderson. Conn. Storrs Sta. Bul. 158, p. 285–311. 1929.

On the nature and cause of "the walking disease" of northwestern Nebraska (necrobiosis et cirrhosis hepatis enzootica). L. Van Es, L. R. Cantwell, H. M. Martin, and J. Kramer. Nebr. Sta. Research Bul. 43, 47 p., illus. 1929.

Pullorum disease (bacillary white diarrhea of chickens). J. R. Beach and S. T. Michael. Calif. Sta. Bul. 486, 31 p., illus. 1930.

An experimental study of tests for the detection of carriers of *Bacterium pullorum*. S. T. Michael and J. R. Beach. Hilgardia [Calif. Sta.], vol. 4, no. 8, p. 185–200, illus. 1929.

Eradication of pullorum disease in Massachusetts (bacillary white diarrhea), 1928–1929. W. R. Hinshaw, E. F. Sanders, and G. L. Dunlap. Mass. Sta. Control Ser. Bul. 48, 36 p., illus. 1929.

Study of bacillary white diarrhea (pullorum disease). R. S. Dearstyne, B. F. Kaupp, and H. S. Wilfong. N. C. Sta. Tech. Bul. 36, 53 p., illus. 1929.

The production of gas by *Salmonella pullorum*, II. J. C. Weldin and H. J. Weaver. R. I. Sta. Bul. 222, 25 p. 1929.

Bacillary white diarrhea: Pullorum infection of the domestic fowl. R. A. Runnells. Va. Sta. Bul. 265, 27 p., illus. 1929.

Scours in sheep and goats in Oregon. J. N. Shaw. Oreg. Sta. Circ. 93, 16 p., illus. 1929.

Spirochetes as the etiological factor in certain specific necroses and hyperplastic formations in swine. J. A. Howarth. Hilgardia [Calif. Sta.], vol. 4, no. 13, p. 395–413, illus. 1930.

The sheep stomach worm. G. H. Lamson and A. F. Schulze. Conn. Storrs Sta. Bul. 157, p. 261–284, illus. 1929.

Vaccination of calves against tuberculosis with Calmette-Guérin culture, BCG. C. M. Haring, J. Traum, F. M. Hayes, and B. S. Henry. Hilgardia [Calf. Sta.], vol. 4, no. 12, p. 307–394, illus. 1930.

Tuberculosis of fowls. R. Graham and F. Thorp, Jr. Ill. Sta. Circ. 354, 12 p., illus. 1930.

Prevention of intestinal worms in chickens. R. Graham and E. C. McCulloch. Ill. Sta. Circ. 344, 15 p., illus. 1929.

Some weedy grasses injurious to livestock, especially sheep. L. H. Pammel. Iowa Sta. Circ. 116, 12 p., illus. 1929.

Poultry diseases, their prevention and control. L. D. Bushnell and C. A. Brandly. Kans. Sta. Bul. 247, 107 p., illus. 1929.
Swine sanitation. L. Van Es. Nebr. Sta. Circ. 39, 14 p. 1930.

AGRICULTURAL ENGINEERING

Life, service, and cost of service of farm machinery. J. B. Davidson. Iowa Sta. Bul. 260, p. 258–275, illus. 1929.
A farm machinery survey of selected districts in Pennsylvania. H. B. Josephson, W. R. Humphries, and L. M. Church. Pa. Sta. Bul. 237, 15 p., illus. 1929.
Substitutes for wooden breakpins. A. H. Hoffman and E. G. McKibben. Calif. Sta. Bul. 482, 22 p., illus. 1929.
Factors affecting the cost of tractor logging in the California pine region. M. E. Krueger. Calif. Sta. Bul. 474, 44 p., illus. 1929.
Nebraska tractor tests. 1920–1929. Nebr. Sta. Bul. 242, 27 p., illus. 1930.
The combine harvester in Minnesota. A. J. Schwantes et al. Minn. Sta. Bul. 256, 50 p., illus. 1929.
The combine harvester in Missouri. M. M. Jones. Mo. Sta. Bul. 286, 39 p., illus. 1930.
The combined harvester-thresher in North Dakota. A. H. Benton et al. N. Dak. Sta. Bul. 225, 49 p., illus. 1929.
Progress report on the use of the combine in South Dakota. G. Lundy, K. H. Klages, and J. F. Goss. S. Dak. Sta. Bul. 244, 63 p., illus. 1929.
A grille for threshing soybean selections. R. P. Bledsoe. Ga. Sta. Circ. 85, 4 p., illus. 1929.
Methods of research in soil dynamics as applied to implement design. M. L. Nichols. Ala. Sta. Bul. 229, 27 p., illus. 1929.
Essentials of a mulch paper laying machine. H. H. Musselman. Mich. Sta. Circ. 126, 7 p., illus. 1929.
A simple sweet potato vine cutter. J. C. C. Price. Miss. Sta. Circ. 84, 3 p., illus. 1929.
The Oregon apple-washer. H. Hartman. Oreg. Sta. Circ. 92, 4 p., illus. 1929.
Big teams on Illinois farms. E. T. Robbins. Ill. Sta. Circ. 355, 32 p., illus. 1930.
Farm power and labor. H. B. Josephson and R. U. Blasingame. Pa. Sta. Bul. 238, 20 p., illus. 1929.
The insulation of fruit and vegetable storages. R. D. Anthony and F. G. Hechler. Pa. Sta. Bul. 241, 28 p., illus. 1929.
Adobe construction. J. D. Long. Calif. Sta. Bul. 472, 56 p., illus. 1929.
Poultry houses and equipment. J. E. Dougherty and H. L. Belton. Calif. Sta. Bul. 476, 100 p., illus. 1929.
Creamery organization and construction. H. Giese and M. Mortensen. Iowa Sta. Bul. 267, p. 101–132, illus. 1930.
Farm milk houses. F. E. Fogle and P. S. Lucas. Mich. Sta. Circ. 123, 7 p., illus. 1929.
Truck crop investigations: Design and operation of commercial sweet potato storage houses. M. A. R. Kelley. Va. Truck Sta. Bul. 67, p. 721–765, illus. 1929.
Irrigation water requirement studies of citrus and avocado trees in San Diego County, California, 1926 and 1927. S. H. Beckett, H. F. Blaney, and C. A. Taylor. Calif. Sta. Bul. 489, 51 p., illus. 1930.
Measurement of irrigation water. G. D. Clyde. Utah Sta. Circ. 77, 40 p., illus. 1929.
Units of measurement and the application of irrigation water. C. C. Wright. Wash. Col. Sta. Pop. Bul. 145, 21 p., illus. 1929.
The control of gullies. R. E. Uhland and J. C. Wooley. Mo. Sta. Bul. 271, 23 p., illus. 1929.
Electrical statistics for California farms. B. D. Moses. Calif. Sta. Circ. 316, 20 p., illus. 1929.
Electric power for the farm. E. W. Lehmann and F. C. Kingsley. Ill. Sta. Bul. 332, p. 373–479, illus. 1929.
The use of electricity on Missouri farms. R. R. Parks. Mo. Sta. Bul. 268, 46 p., illus. 1929.
Rural electric service supplied from central stations in Nebraska in 1927. E. E. Brackett and E. B. Lewis. Nebr. Sta. Bul. 236, 17 p., illus. 1929.
Electric household refrigeration. W. T. Ackerman. N. H. Sta. Bul. 244, 23 p., illus. 1929.
An economic study of farm electrification in New York, with a discussion of rural electrification in the Provinces of Quebec and Ontario, Canada. R. F. Bucknam. N. Y. Cornell Sta. Bul. 496, 65 p. 1929.
Electric hay hoists. F. E. Price, A. W. Oliver, and E. L. Potter. Oreg. Sta. Bul. 255, 16 p., illus. 1929.
Electric brooders. F. E. Price, A. G. Lunn, and F. E. Fox. Oreg. Sta. Bul. 262, 24 p., illus. 1930.
Progress report on the use of small electric motors for (1) cutting ensilage, (2) sawing wood, (3) grinding feed. H. B. Josephson and R. U. Blasingame. Pa. Sta. [Pamphlet], 15 p. 1929.
Costs and uses for electricity on South Dakota farms. R. L. Patty. S. Dak. Sta. Bul. 239, 28 p., illus. 1929.
Cost of electricity for the home electric refrigerator. R. L. Patty. S. Dak. Sta. Bul. 241, 16 p., illus. 1929.
Studies on Raritan River pollution, 1927–28. W. Rudolfs et al. N. J. Stas. Bul. 489, 72 p., illus. 1929.
Action of enzymes on sewage solids. N. S. Chamberlin. N. J. Stas. Bul. 500, 35 p., illus. 1930.
The solar heater. A. W. Farrall. Calif. Sta. Bul. 469, 30 p., illus. 1929.
Effect of lumnite cement and plaster of Paris caps on strength of concrete test cylinders. D. J. Tripp. Colo. Sta. Bul. 349, 12 p., illus. 1929.

ECONOMICS AND SOCIOLOGY

FARM MANAGEMENT AND PRODUCTION

Economic phases of the Arkansas apple industry. A. P. Brodell and C. O. Brennen. Ark. Sta. Bul. 236, 42 p., illus. 1929.
Cost of producing crops on irrigated farms. R. T. Burdick and H. B. Pingrey. Colo. Sta. Bul. 353, 72 p., illus. 1929.
Organizing the Corn-Belt farm for profitable production, based on studies of farms in east-central Illinois. H. C. M. Case, R. H. Wilcox, and H. A. Berg. Ill. Sta. Bul. 329, p. 258–332, illus. 1929.
Relation of farm power and farm organization in central Indiana. O. G. Lloyd and L. G. Hobson. Ind. Sta. Bul. 332, 37 p., illus. 1929.
Why hog profits vary. J. A. Hopkins, jr. Iowa Sta. Bul. 255 (Abridged), 12 p. 1929.
The crop system in Iowa County. J. A. Hopkins, Jr. Iowa Sta. Bul. 261, p. 278–315, illus. 1929.
Horses, tractors and farm equipment. J. A. Hopkins, Jr. Iowa Sta. Bul. 264, p. 375–404, illus. 1929
Cropping systems in Iowa, past and present. E. B. Hurd. Iowa Sta. Bul. 268, p. 133–163, illus. 1930.
An economic study of crops and livestock in the purchase region of Kentucky. J. B. Hutson, W. G. Finn, and Z. L. Galloway. Ky. Sta. Bul. 289, p. 307–433, illus. 1928.
Systems of farming for the purchase region of Kentucky. J. B. Hutson, W. G. Finn, and Z. L. Galloway. Ky. Sta. Bul. 292, p. 25–154, illus. 1929.
An economic study of 239 blueberry farms in Washington and Hancock Counties, Maine. C. H. Merchant. Maine Sta. Bul. 351, p. 45–96, illus. 1929.
Types of farming in Minnesota. L. F. Garey. Minn. Sta. Bul. 257, 36 p., illus. 1929.
Progress report on cost of production route in Jones County, Mississippi. 1928. L. E. Long and J. R Allen. Miss. Sta. Bul. 269, 30 p. 1929.
Economic position of the grape industry in Missouri. F. L. Thomsen and G. B. Thorne. Mo. Sta. Bul. 273, 34 p., illus. 1929.
An economic analysis of production problems in the Bitter Root Valley. S. E. Johnson. Mont. Sta. Bul. 220, 123 p., illus. 1929.

Factors affecting the cost of production of alfalfa hay in western Nevada. F. B. Headley and R. M. Clawson. Nev. Sta. Bul. 117, 45 p., illus. 1929.

Efficiency in dairying. F. B. Headley and C. Venstrom. Nev. Sta. Bul. 118, 18 p., illus. 1930.

Potato production costs in New Hampshire. M. F. Abell. N. H. Sta. Bul. 239, 35 p., illus. 1929.

The production and marketing of New York market peas. D. Walker. N. Y. Cornell Sta. Bul. 475, 137 p., illus. 1929.

An economic study of farm buildings in New York. I. F. Hall. N. Y. Cornell Sta. Bul. 478, 87 p., illus. 1929.

Soil and field crop management for Yates County, New York. H. O. Buckman, H. P. Cooper, and F. B. Howe. N. Y. Cornell Sta. Bul. 482, 83 p., illus. 1929.

Economic studies of dairy farming in New York.—IX, Grade B milk with cash crops and mixed hay roughage, crop year 1925 with five-year summary. J. C. Neethling. N. Y. Cornell Sta. Bul. 483, 93 p., illus. 1929.

Apple varieties: Prices, yields, and acreages. G. P. Scoville and T. E. LaMont. N. Y. Cornell Sta. Bul. 495, 104 p., illus. 1929.

What does it cost to grow a bushel of apples? F. H. Ballou. Ohio Sta. Bul. 435, 20 p., illus. 1929.

Types-of-farming in Oklahoma. J. O. Ellsworth and F. F. Elliott. Okla. Sta. Bul. 181, 84 p., illus. 1929.

Cost and efficiency in producing alfalfa hay in Oregon. H. E. Selby. Oreg. Sta. Bul. 241, 71 p., illus. 1928.

Cost and practices in strawberry production in the Willamette Valley. C. E. Schuster and A. S. Burrier. Oreg. Sta. Bul. 245, 43 p., illus. 1929.

Cost and efficiency in producing hay in the Willamette Valley. H. E. Selby. Oreg. Sta. Bul. 248, 48 p., illus. 1929.

Cost of horse labor on Oregon farms. H. E. Selby, B. W. Rodenwold, and H. D. Scudder. Oreg. Sta. Bul. 250, 14 p. 1929.

Cost of producing silage and kale in the Willamette Valley. H. E. Selby. Oreg. Sta. Bul. 251, 34 p., illus. 1929.

Cost of producing sheep on western Oregon farms. O. M. Nelson. Oreg. Sta. Circ. 94, 31 p., illus. 1929.

Costs of cooling milk on farms. R. B. Corbett. R. I. Sta. Bul. 223, 13 p., illus. 1930.

Piedmont farm business studies. W. C. Jensen and B. A. Russell. S. C. Sta. Bul. 264, 42 p., illus. 1930.

Types of farming in South Dakota. R. H. Rogers and F. F. Elliott. S. Dak. Sta. Bul. 238, 71 p., illus. 1929.

An economic survey of the "Dixie" section, Washington County, Utah, with special reference to production and marketing of truck crops and fruit. W. P. Thomas. Utah Sta. Bul. 214, 56 p., illus. 1930.

Cost reduction in dry-farming in Utah. P. V. Cardon. Utah Sta. Bul. 215, 27 p., illus. 1930.

Studies in Vermont dairy farming.—VI, The position of northern Vermont among American dairy farming regions. J. L. Hills. Vt. Sta. Bul. 307, 32 p., illus. 1929.

The cost of raising dairy cows in West Virginia. P. A. Eke. W. Va. Sta. Bul. 224, 12 p., illus. 1929.

MARKETING AND PRICES

Organization and management of tomato canning factories in Arkansas. C. E. Campbell. Ark. Sta. Bul. 240, 32 p., illus. 1929.

The status of cooperative cotton marketing in Arkansas. B. M. Gile. Ark. Sta. Bul. 245, 44 p. illus. 1929.

Series on California crops and prices: Economic aspects of the sheep industry. E. C. Voorhies and W. E. Schneider. Calif. Sta. Bul. 473, 173 p., illus. 1929.

Walnut supply and price situation. H. E. Erdman and W. U. Fuhriman. Calif. Sta. Bul. 475, 60 p., illus. 1929.

Series on California crops and prices: Asparagus. H. R. Wellman and E. W. Braun. Calif. Sta. Bul. 487, 41 p., illus. 1930.

Series on California crops and prices: Cherries. H. R. Wellman and E. W. Braun. Calif. Sta. Bul. 488, 38 p., illus. 1930.

Fruit markets in Eastern Asia. B. H. Crocheron and W. J. Norton. Calif. Sta. Bul. 493, 366 p., illus. 1930.

The marketing of Delaware sweet potatoes. H. S. Gabriel. Del. Sta. Bul. 161, 45 p., illus. 1929.

Cost of handling citrus fruit from the tree to the car in Florida. H. G. Hamilton. Fla. Sta. Bul. 202, p. 317-428, illus. 1929.

Marketing Georgia peaches. R. M. Middleton. Ga. Sta. Bul. 155, 21 p., illus. 1929.

Factors relating to the price of Idaho potatoes. R. B. Heflebower. Idaho Sta. Bul. 166, 32 p., illus. 1929.

Practices and problems of cooperative livestock shipping associations in Illinois. R. C. Ashby. Ill. Sta. Bul. 331, p. 350-372, illus. 1929.

Livestock truckage rates in Illinois, with a comparison of marketing expense by truck and by rail. R. C. Ashby. Ill. Sta. Bul. 342, p. 118-175, illus. 1930.

Buying tomatoes on grade, 1928. F. C. Gaylord and H. M. Cleaver. Ind. Sta. Bul. 328, 16 p., illus. 1929.

International trade in pork and pork products. K. Bjorka. Iowa Sta. Research Bul. 122, 54 p., illus. 1930.

Does Iowa "dump" its grain? G. S. Shepherd. Iowa Sta. Circ. 118, 24 p., illus. 1929.

Pork products in foreign trade. K. Bjorka. Iowa Sta. Circ. 121, 8 p., illus. 1930.

The production and marketing of strawberries on the Eastern Shore of Maryland. W. E. Whitehouse, W. J. Hart, and W. P. Walker. Md. Sta. Bul. 315, p. 163-217, illus. 1929.

The consumer demand for apples. L. P. Jefferson. Mass. Sta. Bul. 250, p 53-71, illus. 1929.

Economic aspects of local elevator organization. H. Metzger and H. B. Price. Minn. Sta. Bul. 251, 55 p., illus. 1929.

Developing new markets for Missouri butterfat F. L Thomsen and W. H. E. Reid. Mo. Sta. Bul. 267, 32 p., illus. 1929.

The cooperative marketing of fruits and vegetables on the St. Louis market. F. L. Thomsen. Mo. Sta. Bul. 277, 52 p., illus. 1929.

Factors involved in buying Missouri cream. F. L. Thomsen and W. H. E. Reid. Mo. Sta. Research Bul. 137, 26 p., illus. 1930.

Current problems of Montana farmers' elevators. E. J. Bell, Jr. Mont. Sta. Bul. 226, 48 p., illus. 1930.

White Mountain demand for vegetables and poultry products. E. H. Rinear. N. H. Sta. Bul. 241, 26 p., illus. 1929.

Roadside marketing in New Hampshire. M. G. Eastman. N. H. Sta. Bul. 249, 39 p., illus. 1929.

Farmers' cooperation in New Jersey, 1926. C. B. Howe. N. J. Stas. Bul. 487, 95 p. 1929.

Effect of variations in prices of eggs and feed upon farm income. W. F. Knowles. N. J. Stas. Hints to Poultrymen, vol. 18, no. 5, 4 p. 1930.

An economic study of the collection of milk at country plants in New York. L. Spencer. N. Y. Cornell Sta. Bul. 486, 47 p., illus. 1929.

Some facts concerning the distribution of fruits and vegetables by wholesalers and jobbers in large terminal markets. M. P. Rasmussen. N. Y. Cornell Sta. Bul. 494, 115 p., illus. 1929.

Prices of North Dakota farm products. O. M. Fuller and R. E. Willard. N. Dak. Sta. Bul. 232, 51 p., illus. 1929.

Losses in shipping Ohio livestock. G. F. Henning. Ohio Sta. Bul. 438, 80 p., illus. 1929.

The truck and its relationship to livestock marketing in Ohio. G. F. Henning. Ohio Sta. Bul. 440, 45 p., illus. 1929.

Farmers' produce markets in Ohio. C. W. Hauck. Ohio Sta. Bul. 443, 46 p., illus. 1929.

Oregon apple prices, by variety, grade and size, 1922–1926. R. S. Besse and M. R. Cooper. Oreg. Sta. Bul. 244, 24 p., illus. 1929.

Marketing Willamette Valley wools through the Pacific Cooperative Wool Growers. E. B. Mittelman. Oreg. Sta. Bul. 260, 15 p., illus. 1930.

Willamette Valley wools in relation to local consumption. E. B. Mittelman. Oreg. Sta. Bul. 261, 23 p., illus. 1930.

A study of the business practices of farmers' local cooperative purchasing associations in Pennsylvania. J. K. Stern. Pa. Sta. Bul. 242, 30 p., illus. 1929.
The consumption of dairy products by 1370 families in Philadelphia. F. F. Lininger and H. Metzger. Pa. Sta. Bul. 245, 16 p., illus. 1930.
Preferences and practices in buying vegetables in Providence, Rhode Island. R. B. Corbett. R. I. Sta. Bul. 220, 69 p., illus. 1929.
Marketing of poultry products. G. L. Stevenson. S. Dak. Sta. Bul. 243, 12 p., illus. 1929.
Milk receiving station operation in Vermont. O. M. Camburn. Vt. Sta. Bul. 303, 38 p. 1929.
The adjustment of agricultural production to meet home market demands in the Clifton Forge-Covington trade area. J. J. Vernon, T. D. Johnson, and W. O'Byrne. Va. Sta. Bul. 266, 30 p., illus. 1929.
Historical study of prices received by producers of farm products in Virginia, 1801–1927. A. G. Peterson. Va. Sta. Tech. Bul. 37, 218 p., illus. 1929.
Cooperative buying in West Virginia. P. A. Eke. W. Va. Sta. Bul. 221, 55 p., illus. 1929.
Adjusting agricultural production and distribution in the Beckley area to meet home market demands. W. W. Armentrout. W. Va. Sta. Bul. 226, 20 p., illus. 1930.
Adjusting agricultural production and distribution in the Wheeling area to meet home market demands. W. W. Armentrout. W. Va. Sta. Bul. 228, 28 p., illus. 1930.

TAXATION, LAND ECONOMICS, AND CREDIT

The farm credit situation in southwestern Arkansas. B. M. Gile. Ark. Sta. Bul. 237, 62 p., illus. 1929.
The use, value, and cost of credit in agriculture. C. H. West. Calif. Sta. Bul. 480, 47 p., illus. 1929.
Financing the western cattleman. C. I. Bray. Colo. Sta. Bul. 338, 87 p., illus. 1928.
Credit problems of Georgia cotton farmers. A. N. Moore, J. K. Giles, and R. C. Campbell. Ga. Sta. Bul. 153, 56 p., illus. 1929.
The agricultural credit situation in Louisiana. R. L. Thompson. La. Stas. Bul. 208, 101 p., illus. 1930.
Considerations in evaluating Illinois farm lands. Papers delivered at the Bankers and Land Appraisers Short Course at the University of Illinois, November, 1929. Ill. Sta. Circ. 356, 109 p., illus. 1930.
The stock-share lease. W. E. Grimes. Kans. Sta. Circ. 155, 16 p. 1930.
Farm land values in Kansas. H. Howe. Kans. Sta. Circ. 156, 12 p., illus. 1930.
Land valuation, II. J. T. Waddill et al. Mo. Sta. Bul. 269, 47 p. 1929.
The utilization of marginal lands. W. Allen. N. Y. Cornell Sta. Bul. 476, 109 p., illus. 1929.
Abandoned farm areas in New York. L. M. Vaughan. N. Y. Cornell Sta. Bul. 490, 285 p., illus. 1929.
Outline of Colorado tax laws for farmers and ranchmen. G. S. Klemmedson and C. C. Gentry. Colo. Sta. Bul. 355, 17 p. 1929.
The cost of local government in Larimer County, Colorado. G. S. Klemmedson. Colo. Sta. Bul. 361, 84 p., illus. 1930.
The cost of government in Massachusetts, 1910–1926. H. W. Yount and R. E. Sherburne. Mass. Sta. Bul. 256, p. 167–234, illus. 1929.
A comparison of the cost of maintenance of large and of small county boards in the United States; A study in the cost of government. M. S, Kendrick. N. Y. Cornell Sta. Bul. 484, 41 p., illus. 1929.
Farm-property taxation in New York. I. J. Call. N. Y. Cornell Sta. Bul. 485, 49 p., illus. 1929.
Farm income and taxation in North Carolina. G. W. Forster, H. W. Hawthorne, G. S. Klemmedson, and H. H. Wooten. N. C. Sta. Bul. 267, p. 43–188, illus. 1929.
Trends of tax levies in Oregon with emphasis upon rural and city real properties. W. H. Dreesen. Oreg. Sta. Bul. 257, 46 p., illus. 1929.
Taxes on farm and urban real estate in Virginia. R. A. Ballinger and W. Coombs. Va. Sta. Bul. 268, 30 p., illus. 1929.

MISCELLANEOUS

Accounts for Kansas farms. M. Evans and I. N. Chapman. Kans. Sta. Circ. 150, 36 p., illus. 1929.
Income from five hundred hens and one thousand pullets. W. F. Knowles. N. J. Stas. Hints to Poultrymen, vol 18, no. 1, 4 p. 1929.
The relationships between roads and agriculture in New York. J. L. Tennant. N. Y. Cornell Sta. Bul. 479, 84 p., illus. 1929.
Ohio agricultural statistics for 1928. Ohio Sta. Bul. 442, 50 p. 1929.
Estimated income from the Ohio agricultural industry. V. R. Wertz. Ohio Sta. Bul. 450, 37 p., illus. 1930.
Economic conditions of farmers in Oklahoma as related to membership in the Oklahoma Cotton Growers Association. W. W. Fetrow. Okla. Sta. Bul. 186, 23 p., illus. [1929.]
Agricultural outlook for Oklahoma, 1930. P. H. Stephens et al. Okla. Sta. Circ. 76, 20 p. 1930.

SOCIOLOGY

The genesis to farming occupations in Connecticut. J. L. Hypes and J. F. Markey. Conn. Storrs Sta. Bul. 161, p. 381–549, illus. 1929.
Incomes and expenditures of Minnesota farm and city families, 1927–28. C. C. Zimmerman. Minn. Sta. Bul. 255, 50 p., illus. 1929.
Contacts in a rural community. H. J. Burt. Mo. Sta. Research Bul. 125, 75 p., illus. 1929.
Rural community halls in Montana. J. W. Barger. Mont. Sta. Bul. 221, 52 p., illus. 1929.
The rural community club in Montana. J. W. Barger. Mont. Sta. Bul. 224, 52 p., illus. 1930.
Rural population, Tompkins and Schuyler Counties, New York, 1925. B. L. Melvin. N. Y. Cornell Sta. Bul. 487, 58 p., illus. 1929.
Village service agencies, New York, 1925. B. L. Melvin. N. Y. Cornell Sta. Bul. 493, 117 p., illus. 1929.
Social relationships of Slaterville Springs, Brooktondale area, Tompkins County, New York. G. A. Bakkum and B. L. Melvin. N. Y. Cornell Sta. Bul. 501, 55 p., illus. 1930.
Farm family living among white owner and tenant operators in Wake County, 1926. W. A. Anderson. N. C. Sta. Bul. 269, 101 p., illus. 1929.
Factors influencing living conditions of white owner and tenant farmers in Wake County, 1926. W. A. Anderson. N. C. Sta. Tech. Bul. 37, 58 p. 1930.
Relation of town and country interests in Garfield County, Oklahoma. J. F. Page. Okla. Sta. Bul. 194, 47 p., illus. 1930.
The role of the church in rural community life in Virginia. C. H. Hamilton and W. E. Garnett. Va. Sta. Bul. 267, 191 p., illus. 1929.
A study of farm migration in selected communities in the State of Washington. A. A. Smick and F. R. Yoder. Wash. Col. Sta. Bul. 233, 41 p., illus. 1929.
Rural organizations and the farm family. E. L. Kirkpatrick, J. H. Kolb, C. Inge, and A. F. Wileden. Wis. Sta. Research Bul. 96, 56 p., illus. 1929.

REPORTS, PERIODICALS, REGULATORY, AND MISCELLANEOUS PUBLICATIONS

REPORTS

Report of the Alaska Agricultural Experiment Stations, 1928. H. W. Alberts. 39 p., illus. 1929.
Forty-first annual report, fiscal year ending June 30, 1929. D. T. Gray et al. Ark. Sta. Bul. 246, 80 p., illus. 1929.
Report of the agricultural experiment station of the University of California, from July 1, 1928, to June 30, 1929. E. D. Merrill et al. 123 p 1930.

The forty-second annual report of the Colorado Agricultural Experiment Station for the year 1929. C. P. Gillette et al. 75 p. [1929.]

Tobacco substation at Windsor, report for 1929. P. J. Anderson, T. R. Swanback, O. E. Street, et al. Conn. State Sta. Bul. 311, p. 197–273, illus. 1930.

Twenty-ninth report, Connecticut State Entomologist, 1929. W. E. Britton. Conn. State Sta. Bul. 315, p. 479–620, illus. 1930.

Report of the director for the year ending June 30, 1929. W. L. Slate. Conn. Storrs Sta. Bul. 162, 28 p. 1929.

Annual report of the director for the fiscal year ending June 30, 1929. C. A. McCue et al. Del. Sta. Bul. 162, 74 p., illus. 1929.

University of Florida Agricultural Experiment Station report for the fiscal year ending June 30, 1928. W. Newell et al. 123R+iv p., illus. [1929.]

Forty-second annual report, Georgia Experiment Station, for the year 1929. H. P. Stuckey. 39 p., illus. 1929.

Ninth annual report [Georgia Coastal Plain Station], 1928. S. H Starr. Ga. Coastal Plain Sta. Bul. 11, 74 p. 1929.

Report of the Guam Agricultural Experiment Station, 1928. C. W. Edwards et al. 31 p., illus. 1930.

Report of the Hawaii Agricultural Experiment Station, 1928. J. M. Westgate et al. 29 p., illus. 1929.

Report of the Hawaii Agricultural Experiment Station, 1929. J. M. Westgate et al. 34 p., illus. 1930.

Work and progress of the agricultural experiment station for the year ending December 31, 1928. E. J. Iddings et al. Idaho Sta. Bul. 164, 45 p. 1929.

A year's progress in solving farm problems of Illinois: Annual report of Illinois Agricultural Experiment Station for the year ended June 30, 1929. Compiled and edited by F. J. Keilholz. 270 p., illus. 1929.

Report of Moses Fell Annex Farm, Bedford, Indiana, June, 1929. H. J. Reed and H. G. Hall. Ind. Sta. Circ. 164, 16+2 p., illus. 1929.

Fifteenth annual report of the Creamery License Division for the year ending March 31, 1929. T. H. Binney. Ind. Sta. Circ. 166, 20 p., illus. 1929.

A report of the Tribune Branch Agricultural Experiment Station. T. B. Stinson and H. H. Laude. Kans. Sta. Bul. 250, 36 p., illus. 1930.

Forty-first annual report of the agricultural experiment station of the University of Kentucky for the year 1928. Part I, Report of the director, Meteorological summaries. T. P. Cooper. 53 p. [1929.]

Report of the [Louisiana] Agricultural Experiment Stations for the years 1928–1929. C. T. Dowell et al. 67 p. 1930.

Report of the North Louisiana Experiment Station for the years 1928–1929. S. Stewart. La. Stas. Bul. 204, 14 p. 1930.

Report of the Rice Experiment Station for the years 1928–1929. J. M. Jenkins. La. Stas. Bul. 205, 12 p. 1930.

Report of the Fruit and Truck Experiment Station for the years 1928–1929. B. Szymoniak. La. Stas. Bul 206, 8 p. 1930.

The forty-first annual report of the University of Maryland Agricultural Experiment Station, 1927–1928. H. J. Patterson et al. 198 p., illus. [1929.]

The forty-second annual report of University of Maryland Agricultural Experiment Station, 1928–1929. H. J. Patterson. 465 p., illus. [1929.]

Biennial report of the Massachusetts Agricultural Experiment Station, 1927 and 1928. F. J. Sievers et al. Mass. Sta. Bul. 247, p. 297–349. 1929.

[Minnesota] Agricultural Experiment Station, thirty-seventh annual report, July 1, 1928, to June 30, 1929. W. C. Coffey. 58 p. [1929.]

Mississippi Agricultural Experiment Station, fortieth annual report for the fiscal year ending June 30, 1927. J. R. Ricks et al. 62 p.

Mississippi Agricultural Experiment Station, forty-first annual report for the fiscal year ending June 30, 1928. J. R. Ricks et al. 64 p.

Preliminary report of the Holly Springs Branch Experiment Station for 1929. C. T. Ames and O. B. Casanova. Miss. Sta. Circ. 87, 5 p. 1929.

Report of Holly Springs Branch Experiment Station, 1929. C. T. Ames and O. B. Casanova. Miss. Sta. Bul. 272, 23 p., illus. 1929.

Report of the Raymond Branch Experiment Station, 1929. H. F. Wallace and J. L. Cooley, jr. Miss. Sta. Bul. 271, 38 p., illus. 1929.

Report of the South Mississippi Branch Experiment Station. W. R. Perkins, W. S. Anderson, and W. W. Welborne. Miss. Sta. Bul. 274, 34 p., illus. 1929.

How the experiment station solves farm problems.—One year's work, agricultural experiment station. (Report of the director, July 1, 1927, to June 30, 1928.) F. B. Mumford et al. Mo. Sta. Bul. 272, 95 p., illus. 1929.

Biennial report of the Missouri State Fruit Experiment Station, Mountain Grove, 1927-1928. F. W. Faurot. 8 p. [1929.]

Progress in agricultural investigations.—Thirty-fifth annual report of the [Montana] Agricultural Experiment Station, July 1, 1927, to June 30, 1928. F. B. Linfield. 63 p. [1929.]

Forty-second annual report of the agricultural experiment station of Nebraska, [1928]. W. W. Burr et al. 50 p.

Annual report of the board of control [Nevada Station] for the fiscal year ending June 30, 1928. S. B. Doten et al. 30 p.

Annual report of the board of control [Nevada Station] for the fiscal year ending June 30, 1929. S. B. Doten et al. 30 p. illus. 1930.

Agricultural experiments, 1929—Report of the New Hampshire Agricultural Experiment Station. J. C. Kendall. N. H. Sta. Bul. 250, 31 p. illus. 1930.

Fiftieth annual report of the New Jersey State Agricultural Experiment Station and the forty-second annual report of the New Jersey Agricultural College Experiment Station for the year ending June 30, 1929. J. G. Lipman et al. 329 p., illus. [1929.]

Annual report of the Department of Sewage Disposal, July 1, 1927–June 30, 1928. W. Rudolfs et al. N. J. Stas. Bul. 486, 80 p., illus. 1929.

Annual report of the Department of Sewage Disposal, July 1, 1928–June 30. 1929. W. Rudolfs et al. N. J. Stas. Bul. 502, 40 p., illus. 1930.

Fortieth annual report, agricultural experiment, station of the New Mexico College of Agriculture and Mechanic Arts, 1928–1929. F. Garcia. 73 p. illus. 1929.

Forty-eighth annual report of the New York State Agricultural Experiment Station for the fiscal year ended June 30, 1929. U. P. Hedrick. 78 p. 1929.

Cornell University Agricultural Experiment Station, forty-second annual report, 1929. Part I, The College of Agriculture: Resident and extension instruction. A. R. Mann. 101 p. [1930.]

Cornell University Agricultural Experiment Station, forty-second annual report, 1929. Part II, The Cornell University Agricultural Experiment Station. A. R. Mann et al. 89 p. [1930.]

Fifty-first annual report of the North Carolina Agricultural Experiment Station for the fiscal year ended June 30, 1928. Statistical summary for the year ending December 1, 1928. R. Y. Winters et al. 94 p., illus. [1929.]

Fifty-second annual report of the North Carolina Agricultural Experiment Station for the fiscal year ended June 30, 1929. Statistical summary for the year ending December 1, 1929. R. Y. Winters et al. 125 p., illus. [1930.]

Edgeley Substation report for years 1922 to 1928. O. A. Thompson. N. Dak. Sta. Bul. 226, 18 p., illus. 1929.

Hettinger Substation report for 1928. C. H. Plath. N. Dak. Sta. Bul. 229, 28 p., illus. 1929.

Langdon Substation report for 1927 and 1928. V. Sturlaugson. N. Dak. Sta. Bul. 228, 34 p., illus. 1929.

Forty-eighth annual report of the Ohio Agricultural Experiment Station for the year ended June 30, 1929. C. G. Williams et al. Ohio Sta. Bul. 446, 216 p., illus. 1930.

The Pennsylvania Agricultural Experiment Station forty-second annual report for the fiscal year ending June 30, 1929. R. L. Watts et al. Pa. Sta. Bul. 243, 47 p., illus. 1929.
Report of the Porto Rico Agricultural Experiment Station, 1928. D. W. May et al. 38 p., illus. 1929.
Forty-first annual report of the director of the [Rhode Island] Agricultural Experiment Station [1928]. B. E. Gilbert. p. 42–54. 1929.
Forty-second annual report of the South Carolina Experiment Station of Clemson Agricultural College, for the year ended June 30, 1929. H. W. Barre. 122 p., illus. 1929.
Annual report of the South Dakota Agricultural Experiment Station for the fiscal year ending June 30, 1929. J. W. Wilson. 32 p. [1929.]
Forty-first annual report [Texas Agricultural Experiment Station], 1928. A. B. Conner. 144 p., illus. [1929.]
Forty-second annual report [Texas Agricultural Experiment Station], 1929. A. B. Conner. 164 p., illus. [1930.]
Forty-second annual report, 1928–1929. J. L. Hills. Vt. Sta. Bul. 302, 29 p. 1929.
Report of the Virgin Islands Agricultural Experiment Station, 1928. J. B. Thompson et al. 20 p., illus. 1929.
Report of the Virgin Islands Agricultural Experiment Station, 1929. J. B. Thompson et al. 19 p., illus. 1930.
Thirty-ninth annual report for the fiscal year ended June 30, 1929. E. C. Johnson et al. Wash. Col. Sta. Bul. 237, 66 p. 1929.
Annual report of the Western Washington Experiment Station for the fiscal year ending March 31, 1929. J. W. Kalkus et al. West. Wash. Sta. Bul. 14-W, 49 p., illus. 1929.
New science for an old art: Annual report of the director, 1928–1929. H. L. Russell et al. Wis. Sta. Bul. 410, 143 p., illus. 1930.
Thirty-ninth annual report of the University of Wyoming Agricultural Experiment Station, 1928–1929. J. A. Hill. 52 p. [1929.]

PERIODICALS

Quarterly Bulletin, Michigan Agricultural Experiment Station.—vol. 12 (1929–1930), no. 1, 30 p., illus.; no. 2, p. 35–70, illus.; no. 3, p. 75–118, illus.; no. 4, p. 121–166, illus.
Bimonthly Bulletin. Ohio Sta. Bimo. Buls. 139, p. 113–144, illus.; 140, p. 145–176, illus.; 141, p. 179–208, illus.; 142, 32 p., illus.; 143, p. 33–64, illus.; 144, p. 65–96, illus. 1929–1930.
Forest News, Ohio Agricultural Experiment Station.—nos. 1-7, 8 p. each, illus. 1928-1929.
Current Farm Economics, Oklahoma Agricultural Experiment Station.—vol. 2 (1929), no. 1, 4 p.; no. 2, 8 p.; no. 3, 8 p.; no. 4, 8 p.; vol. 3 (1930), no. 1, 8 p.

REGULATORY PUBLICATIONS, FERTILIZERS

Report on inspection of commercial fertilizers, 1929. E. M. Bailey. Conn. State Sta. Bul. 308, 106+xi p. 1929.
Commercial fertilizers. H. R. Kraybill et al. Ind. Sta. Circ. 163, 73 p., illus. 1929.
Analyses of commercial fertilizers. H. E. Curtis, H. R. Allen, and L. Gault. Ky. Sta. Bul. 290, p. 435-531. 1928.
Commercial fertilizers, 1929. J. M. Bartlett. Maine Sta. Off. Insp. 133, p. 49-72. 1929.
Inspection of commercial fertilizers. H. D. Haskins et al. Mass. Sta. Control Ser. Bul. 51, 61 p. 1929.
Inspection of agricultural lime products. H. D. Haskins and H. R. DeRose. Mass. Sta. Control Ser. Bul. 52, 8 p. 1929.
Testing fertilizers for Missouri farmers, 1928. L. D. Haigh. Mo. Sta. Bul. 270, 51 p., illus. 1929.
Testing fertilizers, spring, 1929. F. B. Mumford and L. D. Haigh. Mo. Sta. Bul. 276, 12 p. 1929.
Registration, labeling, inspection, and sale of commercial fertilizers, 1929. L. D. Haigh. Mo. Sta. Bul. 284, 58 p. 1930.
Inspection of commercial fertilizers for 1929, made for the State Department of Agriculture. T. G. Phillips, T. O. Smith, and J. C. Fritz. N. H. Sta. Bul. 248, 12 p. 1929.
Analyses of commercial fertilizers, fertilizer supplies, and home mixtures for 1929. C. S. Cathcart. N. J. Stas. Bul. 490, 35 p. 1929.
Analyses of commercial fertilizers and ground bone; analyses of agricultural lime, 1929. C. S. Cathcart. N. J. Stas. Bul. 493, 29 p. 1929.
Fertilizer registrations for 1930. C. S. Cathcart. N. J. Stas. Bul. 495, 23 p. 1930.
Inspection of fertilizers. W. L. Adams and J. E. Blaney. R. I. Sta. Ann. Fert. Circ., 12 p. 1929.
Analyses of commercial fertilizers. R. N. Brackett and D. H. Henry. S. C. Sta. Bul. 259, 61 p. 1929.
Commercial fertilizers in 1928-29 and their uses. G. S. Fraps and S. E. Asbury. Tex. Sta. Bul. 403, 50 p. 1929.
Commercial fertilizers. L. S. Walker and E. F. Boyce. Vt. Sta. Bul. 301, 24 p. 1929.

REGULATORY PUBLICATIONS, FEEDING STUFFS

Commercial feeding stuffs. H. R. Kraybill et al. Ind. Sta. Circ. 165, 36 p. 1929.
Commercial feeds in Kentucky in 1928. J. D. Turner, H. D. Spears, W. G. Terrell, and L. V. Amburgey. Ky. Sta. Bul. 295, p. 205–233. 1929.
Commercial feeding stuffs, 1928–1929. J. M. Bartlett. Maine Sta. Off. Insp. 132, p. 17–48. 1929.
Inspection of commercial feedstuffs. P. H. Smith. Mass. Sta. Control Ser. Bul. 50, 33 p. 1929.
Inspection of commercial feeding stuffs, 1929, made for the State Department of Agriculture. T. G. Phillips, T. O. Smith, and F. S. Schlenker. N. H. Sta. Bul. 245, 59 p. 1929.
Analyses of commercial feeding stuffs and registrations for 1929. C. S. Cathcart. N. J. Stas. Bul. 488, 104 p. 1929.
Inspection of feeds. W. L. Adams and F. S. Schlenker. R. I. Sta. Ann. Feed Circ., 12 p. 1930.
Commercial feeding stuffs, from September 1, 1928, to August 31, 1929. F. D. Fuller. Tex. Sta. Bul. 404, 173 p. 1929.
Commercial feeding stuffs. L. S. Walker and E. F. Boyce. Vt. Sta. Bul. 293, 32 p. 1929.
Commercial feeding stuffs. L. S. Walker and E. F. Boyce. Vt. Sta. Bul. 305, 38 p. 1929.

REGULATORY PUBLICATIONS, FOODS AND DRUGS

The thirty-third report on food products and the twenty-first report on drug products, 1928, food and drug inspection and related work. E. M. Bailey. Conn. State Sta. Bul. 307, p. 809–848. 1929.
Foods and drugs. J. M. Bartlett. Maine Sta. Off. Insp. 131, 16 p. 1929.

REGULATORY PUBLICATIONS, SEEDS

Inspection of agricultural seeds. H. R. Kraybill et al. Ind. Sta. Circ. 161, 100 p., illus. 1928.
Inspection of agricultural seeds. H. R. Kraybill et al. Ind. Sta. Circ. 169, 118 p. 1929.
Commercial agricultural seeds, 1929; insecticides and fungicides, 1929. J. M. Bartlett et al. Maine Sta. Off. Insp. 134, p. 73-116. 1929.
Seed inspection. P. H. Smith et al. Mass. Sta. Control Ser. Bul. 49, 55 p. 1929.
Results of seed tests for 1929, made for the State Department of Agriculture. M. G. Eastman and B. I. Glidden. N. H. Sta. Bul. 246, 20 p. 1929.
Results of seed and legume inoculant inspection for 1929. J. G. Fiske. N. J. Stas. Bul. 492, 90 p. 1930.
State laws concerning the sale of seeds and legume inoculants. J. G. Fiske. N. J. Stas. Circ. 218, 15 p. 1929.
Agricultural seed. A. S. Lutman. Vt. Sta. Bul. 306, 8 p. 1929.

REGULATORY PUBLICATIONS, MISCELLANEOUS

Stallion enrollment.—XVIII, Report of stallion enrollment board for the year 1929, with lists of stallions and jacks enrolled. Ind. Sta. Circ. 168, 40, p., illus. 1929.

Analyses of materials sold as insecticides and fungicides during 1929. C. S. Cathcart and R. L. Willis. N. J. Stas. Bul. 485, 16 p. 1929.

North Dakota potato grade inspection service: Rules and regulations for its establishment and operation. E. M. Gillig and R. C. Hastings. N. Dak. Sta. Circ. 38, 8 p. 1929.

The chemical composition of insecticides and fungicides. R. H. Robinson and C. F. Whitaker. Oreg. Sta. Circ. 95, 19 p. 1929.

PUBLICATION LISTS AND MISCELLANEOUS

Fifty years' index, 1877–1927. E. H. Jenkins. Conn. State Sta. Bul. 309, p. 109–184. 1929.

Thomas B. Osborne: A memorial. Conn. State Sta. Bul. 312, p. 275,394, illus. 1930.

High points in work in Georgia Experiment Station, commemorating the opening of the Flynt Building. C. A. Whittle. Ga. Sta. Bul. 156, 28 + 3 p., illus. 1929.

Information regarding recent publications. Kans. Sta. Circ. 149, 3 p. 1929.

Abstracts of papers not included in bulletins, finances, meteorology, index. Maine Sta. Bul. 349, p. 177–188. 1928.

Abstracts of Bulletins 393–404 and Circulars 53–54. A. D. Jackson. Tex. Sta. Circ. 56, 23 p. 1929.

Annual summary of publications. B. C. Pittman. Utah Sta. Circ. 78, 8 p. 1929.

LIBRARY SERVICE

An examination of the financial reports of the experiment stations indicates that the stations are using a relatively small part of their total income for library service. The total amount reported as used by all of the stations for this purpose during the year ended June 30, 1930, was $65,084 or 0.36 per cent of the total amount available for station support. The average annual expenditure for library purposes for the 5-year period 1925–1930 was approximately $61,554, varying from $56,331 for the fiscal year 1926 to $65,084 for the fiscal year 1930. This, of course, does not represent all that goes into library service available for station use. Station workers have access to the libraries of the institutions with which the stations are associated, as well as the privilege of interlibrary loans. It would appear, however, that even with the additional sums expended by these institutions for library service the total amount so used is small as compared with the expenditures for other purposes.

The report of the Survey of Land-Grant Colleges and Universities recently issued, says:[3]

"The one outstanding fact in the financial support of libraries of land-grant institutions, which requires emphasis to the exclusion of all others, is the inadequate financial support of the group as a whole. More than 50 per cent of the libraries in the land-grant college group are receiving less than half the funds deemed necessary for adequate service, some less than one-fourth. . . . Until sufficient funds are allotted the library service in most land-grant institutions will remain inadequate for instructional and research needs."

The field of scientific research and the volume of scientific literature have grown so large and are increasing so rapidly that despite the existence of many helpful abstract journals and other bibliographical aids an individual investigator can hardly hope to keep fully informed as to the progress of science even in a limited field without competent library and bibliographical assistance. On this point, the report referred to says:[4]

"The number of agencies doing research in fields from which should come contributions of value to the research worker in agriculture is constantly increasing throughout the world. Each year adds new thousands of documents, books, and journals to the many thousands of past years for the research staff to consider when research is planned, while it is in progress, and when the results are interpreted and conclusions drawn. The day is gone when the research worker can keep abreast of facts, methods, and work under way, through a few journals, books, and pamphlets filed in his office." It appears that inadequate library service may be due in part to failure of the investigator as well as the administrator to appreciate fully the research value of such service.

CORA L. FELDKAMP.

PERSONNEL CHANGES

Only one change occurred in the directorships of the stations in the year ended June 30, 1930, as compared with eight in the preceding year. Other major changes in personnel numbered about the same as in 1929, namely, 115, of which 48 were in the rank of leaders or heads in their respective departments. Ten losses by death were reported, and several changes were caused by either retirement or the giving up of administrative duties to engage exclusively in research or teaching.

[3] KLEIN, A. J. SURVEY OF LAND-GRANT COLLEGES AND UNIVERSITIES. U. S. Dept. Int., Off. Ed. Bul. 9 (1930), v. 1, p. 711. 1930.

[4] KLEIN, A. J. SURVEY OF LAND-GRANT COLLEGES AND UNIVERSITIES. U. S. Dept. Int., Off. Ed. Bul. 9 (1930), v. 2, p. 694. 1930.

CHANGES IN DIRECTORSHIPS

C. B. Hutchison, director of the Giannini Foundation of Agricultural Economics, was appointed on January 20, 1930, director of the California station and dean of the college of agriculture, succeeding E. D. Merrill, who resigned to become director in chief of the New York Botanical Garden.

OTHER CHANGES

Appointments in the rank of associate at the Alabama station included B. F. Alvord in agricultural economics, L. D. Baver in soils chemistry, and Anna L. Sommer in home economics. Otto Brown, extension forester, was transferred as superintendent of the Gulf coast substation recently established at Fairhope. H. S. Swingle was appointed research entomologist. F. W. Parker, soils chemist, and S. J. Schilling, associate in animal nutrition, resigned. E. R. Miller, chemist at the experiment station, died October 31, 1929.

W. T. McGeorge, a former member of the staff, returned to the Arizona station as research chemist in soils, assuming his duties October 1, 1929.

The Arkansas station appointed Margaret E. Smith of the college faculty for home economics research. R. P. Holdsworth was appointed forester at this station, effective in July, 1929.

H. R. Tolley, of the United States Department of Agriculture, was appointed assistant director of the Giannini Foundation at the California station. Appointments in the rank of associate included E. A. Stokdyk in agricultural economics, John Belling in genetics, and W. R. Hinshaw in veterinary science. P. B. Kennedy, for some 15 years agrostologist at the station, died January 18, 1930.

Florence N. Schott was appointed associate in home economics research at the Colorado station. H. L. Morency, associate in veterinary pathology, resigned to take up public health work in the State.

The Connecticut Storrs station appointed C. D. Clark research associate in sociology, effective in September, 1929. C. I. Hendrickson, agricultural economist, resigned in March, 1930, to come to the Department of Agriculture.

The Connecticut State station at New Haven appointed O. E. Street as plant chemist and assigned him to work at the tobacco substation at Windsor.

L. A. Stearns of Ohio, was appointed entomologist at the Delaware station succeeding H. L. Dozier, who resigned to accept a position as chief entomologist for the Service Technique of the Department of Agriculture in Haiti. C. R. Runk, associate agronomist, resigned effective July 31, 1929.

C. M. Tucker of the Porto Rico station was appointed associate plant pathologist at the Florida station to conduct the potato research at the Hastings field laboratory, succeeding L. O. Gratz, who was transferred to Quincy to take charge of the tobacco experiment station. R. V. Allison, soils specialist, was placed in charge of the Everglades station at Belle Glade, and M. N. Walker, associate plant pathologist, was assigned to the new field laboratory established in Lake County. The field laboratory at Homestead was converted into a substation for the study of subtropical horticulture.

K. T. Holley, associate chemist at the Georgia station, succeeded W. G. Friedemann as chemist, effective in September, 1929.

W. V. Halversen was appointed chief bacteriologist at the Idaho station succeeding G. L. A. Ruehle, who resigned to take up work in the Department of Agriculture.

R. W. Stark, for many years associate in crop production in the Illinois station, resigned in the fall of 1929 to engage in private work. Other resignations included John Lamb, jr., associate in soil experiment fields, and Mrs. Rossleene Hetler, associate chief in nutrition in the department of home economics.

B. E. Horrall succeeded R. D. Canan as associate in dairy husbandry at the Indiana station. H. D. Brown, research associate in vegetable gardening, resigned to become head of the division of vegetable gardening, resigned to become head of the division of vegetable gardening at Ohio State University.

Among the major appointments at the Iowa station were C. Y. Cannon, chief in dairy husbandry; J. L. Lush of Texas, chief in animal breeding; and E. W. Henderson of Missouri, chief in poultry husbandry. E. N. Hansen succeeded C. A. Matthews as assistant chief in dairy husbandry, and J. M. Evvard, assistant chief in animal nutrition, resigned.

R. J. Barnett was named acting head of the department of horticulture at the Kansas station during the absence of Albert Dickens, on a year's leave on account of illness. In the spring of 1930, R. C. Smith resumed his duties as station entomologist after an absence of 18 months spent with the Service Technique of the Department of Agriculture in Haiti. W. P. Mortenson was appointed associate agricultural

economist to direct research in fruit and vegetable marketing at the station. J. W. McColloch, associate entomologist, died November 11, 1929.

A. J. Olney, who had been acting in charge of the department of horticulture at the Kentucky station, was made head of that department, effective April 15, 1930.

M. B. Sturgis, of the Texas college, succeeded W. L. Owen as bacteriologist at the Louisiana station, and R. L. Thompson was transferred from the college of commerce to the experiment station to take charge of research in agricultural economics and farm management with especial reference to marketing. Other major appointments in the rank of associate included those of R. J. Saville in farm management research, R. H. Lush in dairy production, J. G. Miller in vegetable crops, and A. H. Meyer in soil research, all effective in July, 1929.

F. V. Owen and A. C. Hildreth, associate biologists at the Maine station, resigned to accept appointments with the Department of Agriculture.

S. W. Wentworth was appointed associate pomologist at the Maryland station, and F. W. Geise, olericulturist, resigned to enter commercial work.

In addition to his duties as director of the Massachusetts station, F. J. Sievers was made director of the graduate school. Henry Van Roekel, formerly in the veterinary diagnostic laboratory, returned as chief of the laboratory succeeding W. R. Hinshaw, resigned. The department of animal and dairy husbandry at the station was divided—V. A. Rice of the teaching faculty being placed in charge of animal husbandry, and J. H. Frandsen appointed head of the department of dairy industry. H. T. Fernald, since 1899 head of the department of entomology of the station, retired from active duty, and the department was combined with that of zoology and geology under the direction of C. E. Gordon. J. P. Jones, research professor of agronomy, resigned.

H. S. Patton, of the University of Cincinnati, was appointed head of the department of economics at the Michigan station, succeeding W. O. Hedrick, who relinquished administrative duties to devote his time exclusively to research. Marie Dye, home economist of the station, was made dean of the department, effective April 1, 1930. V. A. Freeman was tranferred from the extension service to the station staff to fill the vacancy caused by the resignation of W. E. J. Edwards, associate animal husbandman. F. M. Thrun was appointed research associate in economics vice R. W. Newton. Walter Toenjes succeeded H. M. Wells as superintendent of the Graham horticultural substation at Grand Rapids, and Ashley Berridge was appointed superintendent of the new substation at Lake City. C. M. McCrary, farm crops specialist in the extension service, was transferred to the Kellogg demonstration farm at Augusta as superintendent vice G. A. Getman, resigned.

D. S. Buchanan, associate animal husbandman at the Mississippi station, succeeded G. S. Templeton as head of the department, assuming his duties in September, 1929, and J. C. McKee of the teaching staff succeeded J. M. Beal as head of the department of botany.

H. D. Hooker, associate horticulturist at the Missouri station, died October 27, 1929.

R. A. Cooley, head of the department of entomology at the Montana college and station, relinquished administrative duties to devote his time to research for the station and State, the change being effective January 1. 1930. J. R. Parker, entomologist at the station, resigned February 1, 1930, to come to the Department of Agriculture. Hadleigh Marsh was appointed veterinary pathologist to give full time to station work. I. J. Jensen, superintendent of the Judith Basin substation, died May 22, 1930.

E. E. Brackett, associate in agricultural engineering at the Nebraska station, was appointed chairman of the department vice O. W. Sjogren, who resigned in January, 1930. H. L. Wallace, research engineer in charge of tractor testing, died December 6, 1929.

J. C. McNutt, head of the department of animal husbandry at the New Hampshire college and experiment station, died October 12, 1929. M. G. Eastman, of the agronomy department, was made associate in agricultural economics at the station.

In addition to his duties as animal husbandman at the New Jersey stations, F. G. Helyar was made director of resident teaching in the college of agriculture. G. M. Ridenour was added to the station staff as engineer in sewage disposal and water supplies, and E. E. Evaul was promoted from assistant to associate in turf management. B. R. Fudge, physiologist in cranberry work, resigned.

P. J. Chapman of the Virginia truck station was appointed chief in research in entomology at the New York State station to direct entomological investigations on the apple maggot in the Hudson Valley. E. L. Green, associate

in research in chemistry, succeeded F. H. Hall, who died October 17, 1929. H. L. Durham was appointed dairy technologist, W. T. Tapley associate in research in vegetable crops, and J. M. Hamilton associate in research in plant pathology to fill the vacancy caused by the resignation of E. V. Shear, jr.

J. G. Knapp was appointed associate agricultural economist at the North Carolina station, effective September 1, 1929, and Myra deHaven Woodruff, associate in home economics research, assumed her duties in October, 1929. R. W. Leiby, entomologist, resigned.

In addition to their duties as associate agronomists at the Ohio station, G. W. Conrey and H. W. Batchelor were appointed to teaching positions at the college of agriculture. New appointments in the rank of associate agronomist included Richard Bradfield, of Missouri, and E. E. Barnes, by transfer from the teaching faculty of the college. F. S. Howlett, J. S. Shoemaker, I. C. Hoffman, and W. W. Wiggin, of the division of horticulture, were assigned to teaching in addition to their research duties, and H. D. Brown and Alex Laurie, of the college, were made associates in horticulture at the station. R. E. Rebrassier and Alvin Broerman were added to the staff, the former as parasitologist and the latter as animal pathologist. W. K. Greenbank, librarian and editor, died March 18, 1930.

The Oklahoma station announced the appointment of N. E. Winters as assistant director of the station and head of the department of field crops and soils, succeeding in this latter position Adrian Daane, resigned. Earl Weaver, of Iowa, succeeded A.D. Burke as head of the department of dairying and dairy husbandry, and Mrs. Ruth R. St. Julian was appointed research home economist, vice Marjorie Benoy, all the appointments being effective in September, 1929. H. W. Orr, of the college faculty, was added to the station staff as bacteriologist and veterinarian, and F. P. Sanmann was appointed associate in dairy manufacturing.

New appointments in the rank of associate at the Oregon station included W. B. Bollen in bacteriology, F. P. McWhorter in plant pathology, Gustav Wilster in dairy manufactures, and L. G. Gentner in entomology. M. B. McKay, plant pathologist, resigned.

The Pennsylvania station reported the following new members of its staff: M. A. McCarty, associate animal husbandman; Otto Olson, associate agronomist; and J. E. Nicholas, associate in farm machinery. Resignations included M. F. Grimes, animal husbandman; H. S. Newins, wood utilization; and R. J. Miller, research associate in poultry nutrition.

E. S. Garner, agrostologist at the Rhode Island station, resigned in the fall of 1929.

G. H. Collings was designated acting head of the department of agronomy at the South Carolina station, T. S. Buie, agronomist, having resigned to enter commercial work. W. R. Paden succeeded A. H. Meyer as associate agronomist.

R. E. Post was made acting head of the department of farm economics at the South Dakota station during the absence of M. R. Benedict who was granted leave of absence for advanced study at Harvard University.

B. L. Warwick, of Wisconsin, was appointed animal husbandman in charge of breeding investigations at the Texas station. H. P. Smith, of the college faculty, was made chief of the division of agricultural engineering at the station. S. E. Jones succeeded C. J. Todd as entomologist, and J. N. Roney was appointed entomologist for work in the plant lice laboratory at the Dickinson substation. Erwin Jungherr succeeded E. A. Tunnicliff as veterinarian at the Sonora substation, and F. P. Mathews, of Indiana, was appointed veterinarian in charge of the loco investigations laboratory at Alpine. E. Mortensen was appointed superintendent, and S. H. Yarnell, horticulturist, at the newly established substation at Winter Haven. Other major appointments included O. C. Copeland, dairy husbandman, and F. J. Fudge, chemist in cotton root-rot investigations.

The Utah station appointed D. E. Madsen animal pathologist in charge of the new animal-disease laboratory established by recent act of the legislature. H. J. Pack, entomologist of the station, died January 5, 1930, and W. W. Henderson, the associate, was made head of the department. E. G. Carter, associate bacteriologist, was transferred to full-time teaching in the college.

H. C. Taylor was appointed research professor of agricultural economics at the Vermont station.

The Virginia station designated S. A. Wingard, the plant pathologist, acting head of the department of botany and plant pathology, pending the selection of a successor to F. D. Fromme. C. C. Taylor of the teaching faculty was added to the station staff as agricultural economist, and B. L. Hummel was appointed rural sociologist for part-

time work. R. A. Runnells, associate, was made animal pathologist for the station.

E. L. Overholser of the University of California was elected head of the department of horticulture at the Washington station, vice J. R. Magness, who resigned to return to the Department of Agriculture. Harold St. John, the station botanist, resigned to go to the University of Hawaii.

C. R. Orton succeeded N. J. Giddings as plant pathologist at the West Virginia station, assuming his duties September 1, 1929. H. E. Knowlton, associate horticulturist, was made horticulturist of the station and acting head of the department. Gerald Jenny was appointed agricultural editor for the station, vice W. C. Schnopp, who was transferred to the extension service. H. L. Crane, associate horticulturist, resigned to come to the Department of Agriculture as horticulturist in nut investigations.

J. H. Kolb, agricultural economist at the Wisconsin station, was placed in charge of the newly created department of rural sociology. G. W. Keitt, plant pathologist, was made chairman of the department, succeeding L. R. Jones, who relinquished this administrative position. Theodore Macklin, professor of agricultural economics, resigned to accept a position with the Federal Farm Board.

MARY A. AGNEW.

E. W. ALLEN

Agricultural research suffered a great oss in the death of E. W. Allen, which occurred November 11, 1929. His long service in the Office of Experiment Stations, his intimate relations with the experiment stations in the administration of Federal funds for their support, and his varied experience in other positions of responsibility and honor gave him a wealth of knowledge, a breadth of vision, and a maturity of judgment in matters relating to agricultural research that were unsurpassed and made his influence in such matters far-reaching and to a high degree determinative.

In the judgement of his colleagues in the Association of Land-Grant Colleges and Universities, "He successfully solved the problem of administering a national enterprise through local agencies," and did this "at a peculiarly difficult period when the development of men and methods was no less important than the exploration of new fields of research." The Director of Scientific Work of the department, A. F. Woods, said of him: "Few indeed, if any, connected with the experiment station work in this country have contributed as much to it." [5]

Following Doctor Allen's death, Walter H. Evans was made acting chief of the office in addition to his duties as chief of the Division of Insular Stations.

[5] Fuller accounts of Doctor Allen's life and service will be found in U. S. Dept. Agr. Off. Rec. 8 (48): 2; Expt. Sta. Rec. 61: 701; Assoc. Land-Grant Cols. and Univs. Proc. 43: 45. 1929.

INCOME, EXPENDITURES, AND OTHER STATISTICS, 1930

By J. I. Schulte

The following tables give detailed data regarding (1) personnel, publications, and mailing lists of the experiment stations; (2) revenues and additions to equipment; (3) expenditures from the Hatch, Adams, and Purnell funds; and (4) total disbursements from the United States Treasury under the Hatch, Adams, and Purnell Acts from their passage to the end of the fiscal year, June 30, 1930.

Table 3.—*Personnel, publications, and mailing lists of the experiment stations, 1930*

Station	Date of original organization	Date of organization under Hatch Act	Persons on staff	Teachers on staff	Persons on staff who assist in extension work	Publications during fiscal year		Names on mailing list
						Number	Pages	
Alabama	February, 1883	Feb. 24, 1888	49	21	1	5	234	4,000
Alaska			7			1	39	533
Arizona		——, 1889	36	24		8	287	4,000
Arkansas		——, 1887	42	27		12	598	6,000
California	——, 1875	March, 1888	187	104	121	47	2,242	3,395
Colorado		Feb. 29, 1888	67	40		20	620	1,950
Connecticut (State)	Oct. 1, 1875	May 18, 1887	42			18	940	17,414
Connecticut (Storrs)		do	28	12	4	13	549	10,600
Delaware		Feb. 21, 1888	23	7	5	5	215	6,801
Florida		——, 1888	61	1	5	40	616	10,000
Georgia	Feb. 18, 1888	July 1, 1889	24			27	194	1,200
Guam			5					
Hawaii			5			4	148	650
Idaho		Feb. 26, 1892	48	22	9	24	184	15,458
Illinois		Mar. 21, 1888	140	84	18	966	2,518	27,000
Indiana	February, 1885	January, 1888	105	23		38	1,049	38,260
Iowa		Feb. 17, 1888	108	41	4	58	1,080	13,359
Kansas		Feb. 8, 1888	109	75		12	331	13,800
Kentucky	September, 1885	April, 1888	72	24	5	12	505	12,800
Louisiana	April, 1886		43	11	1	9	277	4,848
Maine	March, 1885	Oct. 1, 1887	32	3		9	272	17,355
Maryland	——, 1888	April, 1888	46	27	3	11	343	32,000
Massachusetts	——, 1882	Mar. 2, 1888	66	11	12	50	767	2,887
Michigan		Feb. 26, 1888	115	68	18	32	904	14,419
Minnesota	Mar. 7, 1885	——, 1888	141	104	81	192	1,368	36,000
Mississippi		Jan. 27, 1888	52	13		29	410	19,000
Missouri		January, 1888	86	60		85	1,766	4,996
Montana		July 1, 1893	48	13	6	14	746	6,000
Nebraska	Dec. 16, 1884	June 13, 1887	45	16		19	639	1,926
Nevada		December, 1887	19			3	93	5,000
New Hampshire	——, 1886	Aug. 4, 1887	48	18	23	21	425	8,000
New Jersey (State)	Mar. 10, 1880		[1]85	60	92	499	2,191	25,305
New Jersey (College)		Apr. 26, 1888	43					
New Mexico		Dec. 14, 1889	28	13	5	49	565	10,000
New York (Cornell)	——, 1879	April, 1888	108	74		40	2,248	79,068
New York (State)	March, 1882		57			34	832	10,000
North Carolina	Mar. 12, 1877	Mar. 7, 1887	48	10	1	46	1,011	3,876
North Dakota		March, 1890	58	20	1	15	670	10,300
Ohio	Apr. 25, 1882	Apr. 2, 1888	124	32	2	93	1,367	74,033
Oklahoma		Oct. 27, 1890	47	42		9	116	3,700
Oregon		July, 1888	79	36		28	662	1,750
Pennsylvania		June 30, 1887	121	82		25	508	32,150
Porto Rico			8		1	3	114	1,272
Rhode Island		July 30, 1888	21	4		15	316	5,500
South Carolina		January, 1888	42	11	5	13	549	7,000
South Dakota		Mar. 13, 1887	29	29	2	10	397	5,286
Tennessee	June 8, 1887	Aug. 4, 1887	33	2		12	130	13,755
Texas		Apr. 3, 1889	91			22	769	68,696
Utah		——, 1890	43	27	6	18	428	10,000
Vermont	Nov. 24, 1886	Feb. 28, 1888	27	10	1	20	857	4,000
Virginia	——, 1888	——, 1891	46	16	4	10	431	12,000
Virgin Islands			5		1	2	39	632
Washington		——, 1891	51	23		10	379	16,241
West Virginia		June 11, 1888	46	33	5	37	655	2,114
Wisconsin	——, 1883	——, 1887	100	84	65	16	572	33,063
Wyoming		Mar. 1, 1891	40	16	2	8	252	8,000
Total			3,254	1,473	509	2,868	36,417	777,392

[1] Including 26 also on college station staff, not included in total.

TABLE 4.—*Revenues and expenditures*

Station	Revenues						
	Federal			State	Balances from previous year[1]	Fees	Sales
	Hatch fund	Adams fund	Purnell fund				
Alabama	$15,000	$15,000	$60,000	$191,192.70	$67,825.42		$22,770.42
Alaska[2]							
Arizona	15,000	15,000	60,000	93,910.63	4,716.55		3,849.37
Arkansas	15,000	15,000	60,000	110,031.24			21,537.41
California	15,000	15,000	60,000	784,935.20	21,685.35	$13,748.48	90,768.88
Colorado	15,000	15,000	60,000	116,889.65	26,188.64		33,105.35
Connecticut (State)	7,500	7,500	30,000	206,469.18		23,050.60	
Connecticut (Storrs)	7,500	7,500	30,000	42,000.00	1,874.86	11,197.42	5,004.61
Delaware	15,000	15,000	60,000	18,500.00	2,091.88		20,541.51
Florida	15,000	15,000	60,000	407,395.00	11,240.24		22,508.26
Georgia	15,000	15,000	60,000	25,000.00	29,235.55		10,219.95
Guam[2]							
Hawaii[2]	15,000			33,865.00			21,236.53
Idaho	15,000	15,000	60,000	53,907.29	168.21		5,065.71
Illinois	15,000	15,000	60,000	437,066.30			71,337.08
Indiana	15,000	15,000	60,000	277,275.29	126,653.44	164,197.44	91,857.82
Iowa	15,000	15,000	60,000	245,000.00	525.02		61,309.07
Kansas	15,000	15,000	60,000	124,250.00	30,748.97	55,413.87	12,931.94
Kentucky	15,000	15,000	60,000	142,632.39	30,817.60	129,679.21	52,145.13
Louisiana	15,000	15,000	60,000	105,796.56	34,509.06	38,618.18	21,488.76
Maine	15,000	15,000	60,000	35,000.00	12,412.54	11,460.62	18,347.01
Maryland	15,000	15,000	60,000	71,731.39	2,493.34		31,300.24
Massachusetts	15,000	15,000	60,000	172,712.94		81,577.02	22,666.31
Michigan	15,000	15,000	60,000	332,392.13			33,207.05
Minnesota	15,000	15,000	60,000	250,431.08			102,840.92
Mississippi	15,000	15,000	60,000	161,141.66	9,503.58		
Missouri	15,000	15,000	60,000	49,089.39	30,143.16	35,334.64	52,315.78
Montana	15,000	15,000	60,000	109,109.02			52,786.35
Nebraska	15,000	15,000	60,000	160,050.69			60,644.78
Nevada	15,000	15,000	60,000	4,412.09	1,844.00		5,693.57
New Hampshire	15,000	15,000	60,000	5,500.00	5,875.65		3,515.95
New Jersey (State)				452,125.00		49,813.00	38,120.95
New Jersey (College)	15,000	15,000	60,000				
New Mexico	15,000	15,000	60,000	13,000.00	13,194.20		12,000.00
New York (State)	1,500	1,500	6,000	334,196.63	3,086.76		14,447.12
New York (Cornell)	13,500	13,500	54,000	671,941.78			53,167.04
North Carolina	15,000	15,000	60,000	131,710.78	2,157.37		69,858.56
North Dakota	15,000	15,000	60,000	141,253.50	28,269.49		82,062.11
Ohio	15,000	15,000	60,000	622,600.00	681,229.59		81,437.44
Oklahoma	15,000	15,000	60,000	109,000.00	8,098.64		20,687.71
Oregon	15,000	15,000	60,000	106,250.00	125,435.70	3,935.00	70,828.66
Pennsylvania	15,000	15,000	60,000	123,775.63	521.04		30,686.41
Porto Rico[2]							
Rhode Island	15,000	15,000	60,000		496.78	5,556.00	6,408.27
South Carolina	15,000	15,000	60,000	69,925.55			81,714.53
South Dakota	15,000	15,500	60,000	31,793.75	12,328.64		12,872.53
Tennessee	15,000	15,000	60,000	43,095.50	777.70		29,847.05
Texas	15,000	15,000	60,000	482,974.20	52,247.76		111,572.74
Utah	15,000	15,000	60,000	76,224.07			19,552.55
Vermont	15,000	15,000	60,000		669.13	20,880.88	1,363.98
Virginia	15,000	15,000	60,000	89,705.88	8,632.17		11,981.43
Virgin Islands[2]							
Washington	15,000	15,000	60,000	105,015.81	20,555.51		48,924.54
West Virginia	15,000	15,000	60,000	93,500.00			
Wisconsin	15,000	15,000	60,000	291,707.67			72,806.26
Wyoming	15,000	15,000	60,000	49,622.63	17,669.62		34,020.73
Total	735,000	720,000	2,880,000	8,807,105.20	1,425,923.16	644,462.36	1,855,356.37

[1] Not including balances from Federal funds.
[2] Support from direct appropriations to the U. S. Department of Agriculture given under "Miscellaneous."

for additions to equipment, 1930

Revenues—Continued		Additions to equipment						
Miscellaneous	Total	Buildings	Library	Apparatus	Farm Implements	Livestock	Miscellaneous	Total
----------	$371,788.54	$67,264.62	$1,183.22	$6,710.59	$16,790.42	$1,995.44	----------	$93,944.29
$85,000.00	85,000.00	10,694.86	200.58	854.51	1,747.50	183.00	$1,195.89	14,876.34
----------	192,476.55	3,700.89	15.21	10,686.40	3,693.26	----------	----------	18,095.76
----------	221,568.65	14,348.88	1,700.22	10,787.68	4,360.74	1,125.18	5,805.87	38,128.57
37,329.12	1,038,467.03	204,724.22	11,000.00	----------	----------	----------	51,247.22	266,971.44
4,505.00	270,688.64	345.00	1,152.00	4,000.00	3,614.00	11,767.00	5,751.00	26,629.00
7,596.67	282,116.45	269.55	1,795.95	1,480.98	10,533.82	160.00	1,323.01	15,563.31
350.00	105,426.89	531.50	820.76	2,525.59	94.23	260.00	2,478.11	6,710.19
----------	131,133.39	1,964.01	1,012.67	3,025.31	1,990.81	10.00	----------	8,002.80
----------	531,143.50	54,687.30	4,146.67	14,229.59	9,680.68	2,075.74	11,811.07	96,631.05
----------	154,455.50	2,000.00	887.52	4,340.13	1,200.00	2,074.56	653.10	11,155.31
29,000.00	29,000.00	----------	----------	----------	----------	----------	----------	----------
45,000.00	115,101.53	120.45	387.82	956.48	287.73	----------	----------	1,752.48
----------	149,141.21	4,470.16	169.01	600.52	2,454.43	4,678.18	698.20	13,070.50
----------	598,403.38	28,454.65	5,000.00	----------	22,826.21	----------	----------	56,280.86
81,968.98	831,952.97	17,886.71	955.87	6,433.42	6,116.83	1,261.27	15,567.26	48,221.36
----------	396,834.09	----------	----------	3,858.00	1,026.00	----------	----------	4,884.00
----------	313,344.78	22,113.43	111.82	2,029.23	21,542.87	6,082.37	1,831.54	53,711.26
6,952.85	452,227.18	----------	548.88	3,221.91	1,402.60	1,770.00	1,903.43	8,846.82
6,831.52	297,244.08	27,304.82	190.29	7,353.33	9,734.32	4,199.22	4,128.49	52,910.47
----------	167,220.17	3,950.91	1,094.39	5,429.86	3,197.70	700.00	1,111.50	15,484.36
28,748.26	224,273.23	1,536.03	662.44	3,464.00	4,168.71	801.50	2,416.36	13,049.04
6,760.92	373,717.19	75,000.00	1,495.03	3,786.50	4,272.49	1,000.00	1,203.58	86,757.60
----------	455,599.18	57,428.00	1,321.00	8,672.00	11,938.00	1,759.00	2,329.00	83,447.00
53,516.00	496,788.00	26,222.30	2,549.97	9,084.36	17,740.61	7,507.12	----------	63,104.36
3,700.00	264,345.24	23,245.00	142.37	2,429.30	7,256.98	1,569.70	215.72	34,859.07
22,562.77	279,445.74	431.42	922.12	9,411.76	3,773.73	1,287.87	----------	15,826.90
64.14	251,959.51	----------	437.00	793.00	1,980.00	2,320.00	----------	5,530.00
----------	310,695.47	11,565.42	289.47	5,147.05	3,748.94	18,966.17	1,628.76	41,345.81
----------	101,949.66	1,064.36	154.00	600.00	66.12	471.00	300.00	2,655.48
34,246.74	139,138.34	1,076.89	950.68	3,107.59	2,480.34	269.50	1,623.03	9,508.03
3,000.00	543,058.95	1,347.20	3,331.63	15,538.43	999.95	1,310.50	2,504.89	25,032.60
----------	90,000.00	----------	----------	----------	----------	----------	----------	----------
----------	128,194.20	4,837.11	218.44	1,059.73	4,739.61	1,744.56	1,665.28	14,264.73
----------	360,730.51	----------	1,521.83	2,042.35	13,228.81	350.00	2,986.78	20,129.77
13,126.79	819,235.61	254,578.89	2,563.43	9,571.92	10,035.47	1,781.96	12,095.06	290,626.73
5,543.53	299,270.24	1,191.35	682.79	1,222.92	1,854.91	2,590.89	7,351.86	14,894.72
5,500.00	347,085.10	3,000.00	1,170.00	1,713.00	8,242.00	9,581.00	----------	23,706.00
7,615.00	1,482,882.03	10,034.36	1,669.06	1,191.35	22,687.50	12,587.35	62,030.87	110,200.49
37,237.19	265,023.54	46,396.78	1,329.75	4,432.06	1,420.16	12,486.80	68,407.67	134,473.22
11,990.60	408,439.96	37,596.00	8.00	1,376.41	4,821.23	1,755.50	2,110.25	47,667.39
----------	244,983.08	85,800.00	33.80	5,054.36	1,555.14	295.00	1,428.00	94,166.30
59,000.00	59,000.00	6,572.29	131.81	----------	716.63	106.00	----------	7,526.73
----------	102,461.05	11,972.00	664.00	590.00	1,588.00	382.00	320.00	15,516.00
----------	241,640.08	13,407.04	831.50	1,142.98	7,856.44	5,496.50	2,694.37	31,428.83
5,005.58	152,000.50	----------	----------	2,200.00	2,000.00	----------	1,000.00	5,200.00
----------	163,720.25	1,870.98	609.64	2,511.79	4,679.63	----------	2,279.27	11,951.31
74,050.57	810,845.27	67,618.77	1,583.68	7,338.04	21,190.36	2,576.00	5,564.42	105,871.27
1,000.00	186,776.62	1,841.56	610.48	5,863.55	2,460.35	315.00	860.20	11,951.14
----------	112,913.99	205.24	523.91	3,820.59	----------	371.25	----------	4,920.99
----------	200,319.48	1,340.97	725.08	3,213.94	890.92	----------	989.71	7,160.62
29,000.00	29,000.00	389.43	58.35	----------	113.01	----------	----------	560.79
5,926.28	270,422.14	3,851.66	3,207.95	5,178.54	3,572.49	----------	841.01	16,651.65
55,220.63	238,720.63	20,281.61	192.60	3,535.96	6,719.72	8,318.67	2,322.75	41,400.71
75,927.62	530,441.55	14,414.00	1,369.89	5,570.00	3,694.01	4,677.92	4,079.23	33,805.05
----------	191,312.98	1,441.74	750.00	3,176.90	2,858.65	4,111.10	----------	12,338.39
843,276.76	17,911,123.85	1,252,390.36	65,083.98	222,393.91	307,645.06	145,131.82	296,753.76	2,289,398.89

TABLE 5.—*Expenditures from United States appropriations received under*

Station	Amount of appropriation	Classified expenditures						
		Salaries	Labor	Publications	Postage and stationery	Freight and express	Heat, light, water, and power	Chemical supplies
Alabama	$15,000	$10,220.00	$2,106.60	$327.50	$682.50	$89.53	$3.15	$4.14
Arizona	15,000	14,999.52			.48			
Arkansas	15,000	6,480.00	3,102.50	2,428.06	110.13	120.22	46.58	173.53
California	15,000	15,000.00						
Colorado	15,000	14,738.17		261.83				
Connecticut (State)	7,500	7,500.00						
Connecticut (Storrs)	7,500	7,500.00						
Delaware	15,000	8,455.64	1,167.16	1,422.49	952.11	16.39	495.30	255.30
Florida	15,000	15,000.00						
Georgia	15,000	5,920.00	2,014.88	374.32	969.79	330.28	330.43	22.34
Hawaii	15,000	8,790.73	3,004.71		75.31	5.30		334.87
Idaho	15,000	9,290.95	4,133.40	415.06	31.30	15.79		28.95
Illinois	15,000	14,950.00	50.00					
Indiana	15,000	14,910.00	90.00					
Iowa	15,000	8,115.00	384.38	1,154.32	128.10		61.49	221.78
Kansas	15,000	9,700.00	4,634.24		20.12			1.10
Kentucky	15,000	14,743.64						
Louisiana	15,000	6,734.98	5,982.36	1,267.22	127.57	4.83	25.14	
Maine	15,000	9,108.00	2,155.98	121.20	212.29	55.80	920.05	
Maryland	15,000	14,974.00			26.00			
Massachusetts	15,000	14,782.25			.60			
Michigan	15,000	15,000.00						
Minnesota	15,000	15,000.00						
Mississippi	15,000	9,608.42	1,996.15		79.81	237.18	84.11	
Missouri	15,000	7,980.76	3,295.44	163.79	356.19	124.68	26.50	72.98
Montana	15,000	7,800.00	4,287.98	1,325.49	201.75	45.63	75.83	213.17
Nebraska	15,000	15,000.00						
Nevada	15,000	9,427.67	2,945.04	92.00	406.22	2.25	189.38	24.53
New Hampshire	15,000	9,180.16	896.44	1,226.69	888.86	327.69	700.00	82.56
New Jersey	15,000	10,700.00	1,630.62	31.40	249.66	.52	72.96	200.85
New Mexico	15,000	8,524.94	2,878.53	1,478.63	113.85	97.63	395.65	29.52
New York (Cornell)	13,500	7,716.00	4,114.63		225.24	32.47		182.61
New York (State)	1,500	1,250.00	250.00					
North Carolina	15,000	12,913.00	122.12		22.13	91.87		41.96
North Dakota	15,000	15,000.00						
Ohio	15,000	6,447.50	3,509.23	548.30				538.57
Oklahoma	15,000	4,084.00	3,422.45	529.79	632.71	169.61	42.30	583.77
Oregon	15,000	9,400.00	3,810.19	284.01	134.11	4.85	208.71	25.49
Pennsylvania	15,000	12,558.93	886.89	1,348.45	18.49			
Rhode Island	15,000	5,860.34	3,749.62	911.15	587.87	151.06	251.80	30.71
South Carolina	15,000	8,982.13	1,460.72	1,167.14	448.11	75.36	6.25	155.67
South Dakota	15,000	8,248.27	3,228.21	2,530.97	50.90		13.55	175.96
Tennessee	15,000	10,661.38	1,508.49	832.28	428.49	45.18	1,002.43	13.12
Texas	15,000	12,517.48	1,072.62		53.32	13.39		28.75
Utah	15,000	9,175.14	1,907.36	222.03	109.69	61.29	14.70	324.68
Vermont	15,000	8,796.37	1,691.68	726.82	407.83	23.80	777.68	68.75
Virginia	15,000	6,872.77	3,509.77	289.35	738.16	275.92	659.60	197.02
Washington	15,000	10,741.23	2,123.33	672.40	38.80			401.52
West Virginia	15,000	6,500.00	3,913.47	132.15	15.00		37.45	545.03
Wisconsin	15,000	13,344.23	925.00	730.77				
Wyoming	15,000	8,182.79	5,436.30		9.95	13.95	94.57	88.59
Total	735,000	519,386.39	93,398.49	23,015.61	9,553.44	2,432.47	6,535.61	5,067.82

the act of March 2, 1887 (Hatch Act), for the year ended June 30, 1930

Classified expenditures—Continued										
Seeds, plants, and sundry supplies	Fertilizers	Feeding stuffs	Library	Tools, implements, and machinery	Furniture and fixtures	Scientific apparatus	Livestock	Traveling expenses	Contingent expenses	Buildings and land
$186.73	$100.00	$675.75		$430.00	$86.10			$88.00		
557.98	89.20	1,096.66	$10.00	10.49	254.02	$351.08	$18.45	146.10	$5.00	
263.53	108.32		705.56	108.77	466.49	116.08		443.48	6.00	$17.38
940.52	631.72	40.73	710.33	1,083.52	506.42	5.90		345.06	25.00	748.76
212.45		916.14		4.45	758.70	669.44		227.90		
170.90		1.45		127.71	46.65			732.84	5.00	
804.04		3,953.03		3.90	21.35	58.36		94.25		
101.86				287.24				255.44		
								256.36		
379.14	287.38	2.70		152.90				15.95		19.83
140.13		1,745.49	394.74	34.27	100.28	9.10				2.67
								217.15		
647.40	196.00	195.80		696.41		1,027.87	50.00	167.52		13.33
254.06	22.21	1,232.71	422.53	148.95	261.88	19.54	14.00	191.75	20.70	391.33
258.68	10.85	120.00	57.07	25.98	80.52	38.05		459.00		
502.31	14.25	539.64	106.39	95.27	256.00		25.00	272.80	54.50	46.75
260.51	106.05		564.10	3.39	12.36	207.39		527.70	9.10	7.00
242.58	2.33	360.00	122.47	154.74	22.50	23.72		1,020.77	31.38	133.50
647.16	21.55		17.60	515.87	15.00			173.24		90.83
131.72				84.54	474.38	348.94		189.47		
155.28	26.40			9.68				1,617.56		
	33.75	3,149.51			467.04	306.10				
943.84	52.85	1,049.93	73.79	995.12	581.43	129.18	159.79	1,495.84		53.60
166.81	83.10		7.14	56.83	2.50	108.50		643.34	13.50	50.92
	180.58			6.66						
746.44	375.08	195.82	488.52	271.31	109.59	97.14	100.00	450.30		623.25
501.75	353.48	404.16	486.86	542.93	231.08			145.21	16.25	22.90
100.46	1.50	304.53	7.74	74.58	.83	262.50				
112.76			202.42	36.53	31.50	3.25		119.45	2.72	
76.88			3.60	3.60	499.50		625.00			105.86
528.59		1,206.66	37.82	101.53	75.00	273.32		890.17		72.02
223.62	56.11		302.30	222.26	159.68	574.74	26.25	410.06	75.77	456.28
183.12	111.40	674.09	246.36	49.92	181.30	613.68		86.11	33.33	278.10
75.27	4.00			218.51	1.34	252.30		471.30		
907.59	172.07			1,796.20	13.53	241.18	100.00	626.33		
468.89		496.85		81.58		33.30		93.23		
1,893.00	3,040.18	18,361.65	4,967.34	8,435.64	5,716.97	5,770.66	1,118.49	12,873.68	298.25	3,134.31

TABLE 6.—*Expenditures from United States appropriations received under*

Station	Amount of appropriation	Classified expenditures						
		Salaries	Labor	Postage and stationery	Freight and express	Heat, light, water, and power	Chemical supplies	Seeds, plants, and sundry supplies
Alabama	$15,000	$9,602.09	$883.23	$34.89	$69.19	$81.39	$233.84	$44.80
Arizona	15,000	9,182.78	1,992.38	42.02	76.22		286.30	284.46
Arkansas	15,000	9,116.66	1,997.43	34.40	130.38	55.59	1,091.03	368.19
California	15,000	15,000.00						
Colorado	15,000	15,000.00						
Connecticut (State)	7,500	7,500.00						
Connecticut (Storrs)	7,500	7,500.00						
Delaware	15,000	11,385.68	1,875.81	4.95	33.89		886.51	281.14
Florida	15,000	15,000.00						
Georgia	15,000	8,302.27	1,066.23	21.80	315.68	662.89	644.48	164.85
Idaho	15,000	12,686.74	798.21	13.75	2.43		744.95	136.51
Illinois	15,000	9,628.01	5,371.99					
Indiana	15,000	12,088.33	588.31	48.09	4.98		502.44	487.97
Iowa	15,000	9,095.00	3,691.88	33.48		167.22	858.01	360.32
Kansas	15,000	10,300.00	3,511.16		2.33		352.07	23.19
Kentucky	15,000	14,189.86	75.08		2.13	78.84	517.18	56.40
Louisiana	15,000	10,138.40	1,357.47	18.95	72.35		242.06	174.77
Maine	15,000	15,000.00						
Maryland	15,000	14,766.66		12.04			103.75	25.69
Massachusetts	15,000	15,000.00						
Michigan	15,000	15,000.00						
Minnesota	15,000	15,000.00						
Mississippi	15,000	9,770.74	4,174.70		52.16	74.98	83.27	228.61
Missouri	15,000	3,174.19	4,881.50	82.45	173.54	61.16	1,168.34	547.37
Montana	15,000	10,524.40	1,866.57	45.66	9.75		493.19	178.59
Nebraska	15,000	15,000.00						
Nevada	15,000	8,757.33	3,052.99	35.80	12.02		248.53	114.37
New Hampshire	15,000	11,723.75	630.10	14.99	22.12		311.90	41.00
New Jersey	15,000	11,775.00	345.02	32.53	.85	471.85	1,494.44	143.12
New Mexico	15,000	10,189.49	2,267.51	43.75	151.15	442.55	588.71	338.70
New York (Cornell)	13,500	12,603.89	420.91	9.58			322.51	16.11
New York (State)	1,500	1,500.00						
North Carolina	15,000	12,300.00	450.10	140.99	44.77	79.77	690.51	205.06
North Dakota	15,000	15,000.00						
Ohio	15,000	8,916.66	4,887.54		6.63			517.08
Oklahoma	15,000	8,911.66	1,653.42		26.75		739.77	729.43
Oregon	15,000	12,060.17	1,168.54	11.03	46.82	155.98	622.75	328.07
Pennsylvania	15,000	14,100.00	690.31		3.86		129.39	4.62
Rhode Island	15,000	9,924.35	2,801.01	4.49	27.75	285.01	253.98	114.56
South Carolina	15,000	10,567.79	311.06	324.96	38.47	684.42	277.34	154.69
South Dakota	15,000	7,141.58	5,263.42	77.13	32.09		457.04	116.53
Tennessee	15,000	12,011.00	485.17	5.98	55.99	162.93	420.91	175.44
Texas	15,000	13,904.16	418.80	15.99	40.36		254.10	215.74
Utah	15,000	8,700.12	2,854.75	18.02	23.32		885.52	414.51
Vermont	15,000	9,226.17	1,678.02	147.49	75.81	79.11	924.21	601.14
Virginia	15,000	12,949.86	1,330.04	3.60			217.98	173.39
Washington	15,000	12,530.44	1,036.39	5.65			585.51	154.78
West Virginia	15,000	10,966.59	1,198.78	80.62		41.08	202.79	297.76
Wisconsin	15,000	11,523.81	3,476.19					
Wyoming	15,000	12,906.07	539.67	20.94	44.91		638.99	70.79
Total	720,000	559,141.70	71,091.69	1,386.02	1,598.70	3,584.77	18,474.30	8,289.75

the act of March 16, 1906 (Adams Act), for the year ended June 30, 1930

Classified expenditures—Continued									
Fertilizers	Feeding stuffs	Library	Tools, implements, and machinery	Furniture and fixtures	Scientific apparatus	Livestock	Traveling expenses	Contingent expenses	Buildings and land
$13.33	$225.00		$800.90	$7.06	$2,911.93				$92.35
26.50		$11.21	69.63	350.00	1,245.69		$1,374.38	$28.43	30.00
74.20	741.69	26.76	35.55	198.78	854.03		268.45	5.00	1.86
		15.18	53.05	60.75	295.46	$10.00	97.58		
	923.98	4.50	167.70	4.99	1,878.30	527.06	287.20		28.07
	58.44		18.10	11.25	141.36		325.48	7.80	54.98
	220.25	47.08	531.00		386.05	95.50			
13.20	659.43		2.61	4.45	114.40				
	199.35		185.00		113.40	313.50			
13.60	24.24			12.23	30.44				
9.94	495.84	36.80	352.88	46.40	1,926.92	93.75	33.47		
23.11	7.50				43.50		17.75		
254.63	7.20	5.00	259.74				85.77	3.20	
13.89	2,585.70	9.60	426.98	91.98	1,252.35	316.10			214.85
		8.07	370.05	143.66	734.32		546.53		79.21
	1,243.31	12.68	210.82	12.00	347.01	509.46	443.68		
24.50	500.92		127.46	423.49	509.53		117.77		552.47
		75.53	27.12	35.70	231.31		27.21	102.55	237.77
53.00		4.50	127.00	29.50	599.25		44.29		120.60
			3.67		93.33				30.00
9.15	146.43		152.27	27.29	188.42		515.24		50.00
	76.88		534.06	31.75		29.40			
64.56	1,552.42		121.50	333.68	586.27	34.00	30.00		2'6.54
75.75	14.90	14.08	146.83		336.52		18.56		
			12.00		59.82				
210.50	668.21	66.97	11.70		296.94	50.00			284.53
	10.77		310.10	814.70	990.82	8.00	282.88		224.00
35.81		60.63	130.56	152.90	330.55		812.05		389.77
		312.93	64.67	323.17	725.49		45.76		210.56
	23.85			20.00	87.00	20.00			
		6.00	633.43	150.31	173.31		768.72		371.99
49.31	2.80	30.68	188.58	372.16	1,480.29		71.14		73.09
			133.25		74.25		86.07		31.56
			9.54		329.72		347.97		
108.51	120.37		234.82		1,252.52	100.00	396.16		
	30.10	.35	122.90		217.91	36.35	274.22		96.80
1,073.49	10,539.58	748.55	6,575.41	3,658.20	20,838.41	2,143.12	7,318.33	146.98	3,391.00

TABLE 7.—*Expenditures from United States appropriations received under*

Station	Amount of appropriation	Classified expenditures						
		Salaries	Labor	Publications	Postage and stationery	Freight and express	Heat, light, water, and power	Chemical supplies
Alabama	$60,000	$38,627.10	$6,595.91	----------	$321.94	$338.59	$352.55	$1,524.47
Arizona	60,000	34,438.14	4,805.12	$342.56	59.15	571.85	213.32	2,692.13
Arkansas	60,000	42,646.30	2,383.86	4,721.56	723.55	172.95	118.68	910.08
California	60,000	57,756.40	2,243.60	----------	----------	----------	----------	----------
Colorado	60,000	50,790.17	2,065.66	129.18	242.29	21.07	----------	610.35
Connecticut (State)	30,000	19,616.28	4,178.53	----------	105.30	8.34	----------	1,436.43
Connecticut (Storrs)	30,000	20,047.41	1,685.83	----------	648.60	12.23	----------	----------
Delaware	60,000	40,442.61	4,807.00	1,066.28	204.25	137.60	429.33	838.46
Florida	60,000	40,230.00	6,163.24	1,651.69	352.98	90.53	7.75	2,014.12
Georgia	60,000	24,811.34	9,340.70	562.71	341.69	1,261.31	1,784.67	1,380.81
Idaho	60,000	46,322.69	3,444.33	1,011.09	211.55	244.54	412.60	1,224.94
Illinois	60,000	34,121.97	5,774.41	2,629.64	845.80	584.43	----------	196.41
Indiana	60,000	38,280.62	8,050.20	634.50	1,059.08	251.49	42.46	359.09
Iowa	60,000	33,720.71	10,144.61	1,760.69	864.69	160.69	643.86	1,294.62
Kansas	60,000	30,000.00	20,030.49	401.55	123.78	48.06	72.62	919.06
Kentucky	60,000	48,144.14	3,548.34	344.57	330.46	25.97	73.54	839.24
Louisiana	60,000	40,509.16	6,673.33	10.20	179.84	262.98	308.88	495.92
Maine	60,000	40,349.10	1,467.94	64.39	400.31	280.73	49.95	655.52
Maryland	60,000	41,943.88	4,656.19	136.75	450.05	1.75	5.68	1,460.47
Massachusetts	60,000	48,640.56	2,488.97	1,287.10	227.31	49.03	18.70	410.32
Michigan	60,000	44,521.92	5,495.16	161.14	504.74	10.76	----------	862.33
Minnesota	60,000	47,992.04	482.41	481.98	17.01	250.79	----------	281.45
Mississippi	60,000	35,565.45	7,332.71	148.20	431.96	517.48	328.06	249.10
Missouri	60,000	22,919.49	13,863.48	1,563.26	881.88	753.35	341.15	2,567.11
Montana	60,000	32,395.75	17,271.71	197.86	536.61	151.59	----------	727.50
Nebraska	60,000	38,101.08	7,678.15	2,091.99	97.17	26.24	8.17	919.42
Nevada	60,000	33,689.64	10,988.34	530.15	550.03	199.86	248.10	1,172.19
New Hampshire	60,000	42,977.53	3,607.83	1,117.39	367.47	349.26	.22	920.01
New Jersey	60,000	38,865.00	6,111.98	16.43	250.95	33.65	396.84	1,744.52
New Mexico	60,000	28,528.65	8,864.67	2,070.91	850.77	523.81	487.92	347.17
New York (Cornell)	54,000	44,325.95	316.48	45.04	861.41	9.04	----------	839.56
New York (State)	6,000	4,500.00	1,256.50	----------	----------	----------	----------	34.49
North Carolina	60,000	39,384.70	5,444.22	1,924.64	375.56	236.40	119.51	1,068.87
North Dakota	60,000	52,289.71	686.05	1,558.42	181.15	10.05	----------	441.83
Ohio	60,000	33,032.50	13,405.55	385.13	----------	7.55	1,207.55	254.55
Oklahoma	60,000	29,957.45	12,485.44	1,383.90	588.84	83.28	131.65	607.13
Oregon	60,000	35,400.33	6,985.94	4,182.32	329.76	225.44	231.51	697.21
Pennsylvania	60,000	38,088.42	6,152.67	1,198.47	127.58	551.06	305.12	742.31
Rhode Island	60,000	38,269.66	8,271.17	968.59	377.92	271.15	600.84	166.51
South Carolina	60,000	38,345.89	5,529.61	1,880.26	707.21	139.56	89.66	983.92
South Dakota	60,000	29,672.22	12,795.05	3,881.40	698.67	128.19	58.68	806.53
Tennessee	60,000	49,144.20	639.70	----------	170.21	416.20	155.25	1,029.23
Texas	60,000	28,401.64	12,498.22	----------	1,317.80	376.85	1.00	2,506.95
Utah	60,000	35,070.10	9,811.16	890.52	515.31	336.22	139.21	623.23
Vermont	60,000	31,984.27	9,187.60	2,312.24	701.43	123.10	1,745.26	1,151.79
Virginia	60,000	36,101.44	5,946.62	5,480.58	525.45	15.10	38.22	342.03
Washington	60,000	42,695.91	7,566.61	1,620.75	211.17	15.96	55.00	1,070.91
West Virginia	60,000	39,686.34	3,982.61	891.36	102.86	3.42	182.46	303,93
Wisconsin	60,000	43,374.23	8,585.38	----------	19.97	----------	----------	459.10
Wyoming	60,000	40,043.98	7,429.12	610.00	143.57	70.03	----------	519.88
Total	2,880,000	1,866,764.07	331,220.40	54,347.39	20,137.08	10,359.53	11,405.97	43,703.20

the act of February 24, 1925 (Purnell Act), for the year ended June 30, 1930

Classified expenditures—Continued

Seeds, plants, and sundry supplies	Fertilizers	Feeding stuffs	Library	Tools, implements, and machinery	Furniture and fixtures	Scientific apparatus	Livestock	Traveling expenses	Contingent expenses	Buildings and land
$302.25	$27.00	$1,085.64	$305.94	$3,050.61	$1,591.41	$2,855.75	$55.50	$2,225.60	----	$739.74
378.67	752.00	795.91	4.00	1,454.93	615.73	6,343.85	----	3,945.82	$23.61	2,563.21
130.43	----	97.65	459.18	360.57	2,774.95	2,315.23	----	2,138.61	32.90	13.50
192.56	20.00	163.13	122.02	4.75	586.17	531.56	104.10	3,832.23	14.75	570.01
352.88	786.07	----	----	1,369.77	2.01	887.39	----	1,105.94	131.93	19.13
----	----	----	44.37	----	2,478.11	1,144.03	----	3,939.42	----	----
863.11	287.12	2,268.71	266.07	1,127.62	789.86	2,613.77	----	3,140.77	92.23	625.21
1,071.50	151.00	843.53	28.44	220.95	1,343.83	1,640.59	132.25	3,402.39	13.30	641.91
2,012.71	910.32	6,210.59	172.69	1,607.21	403.68	2,455.93	1,547.50	2,677.51	----	2,518.63
535.34	----	490.18	65.31	189.68	438.95	394.20	37.00	4,878.58	12.92	86.10
140.31	----	827.36	166.71	2,687.38	2,325.38	3,145.69	155.05	6,295.49	65.00	38.97
577.06	----	22.55	----	420.48	680.54	1,616.93	----	7,926.50	78.50	----
2,149.23	76.77	3,205.48	----	43.80	161.63	1,152.46	995.04	3,544.72	81.00	----
655.05	----	323.52	4.25	1,780.55	455.78	1,240.24	2,318.20	1,388.10	15.51	223.24
158.27	7.89	1,034.19	----	----	714.65	776.18	56.87	3,945.69	----	----
1,237.19	104.58	1,321.12	42.85	1,958.33	459.65	2,254.34	2,050.00	1,687.35	----	444.28
1,039.61	260.15	1,315.21	123.55	1,765.02	1,713.63	3,744.26	----	6,166.28	389.61	214.74
438.89	291.85	1,228.33	15.62	1,287.73	1,699.55	1,178.20	110.00	5,095.06	----	----
718.05	----	78.41	122.47	1,118.22	591.94	744.12	63.75	3,419.07	----	21.98
702.96	----	97.15	123.96	436.20	1,076.20	489.38	----	5,185.70	332.40	----
880.89	----	871.96	.75	97.59	635.13	5,386.18	545.72	1,865.97	150.00	60.13
1,258.25	550.88	1,699.80	55.33	5,760.17	479.76	2,186.28	835.09	2,515.84	27.82	57.82
2,172.52	20.00	4,729.60	20.91	841.88	1,036.09	4,423.07	957.77	1,709.88	368.32	830.24
1,092.91	69.74	10.70	114.65	547.83	942.57	520.29	109.70	5,228.59	2.10	79.90
302.33	----	4,711.41	45.74	179.12	1.11	2,540.88	1,082.73	1,908.33	12.07	294.06
990.52	105.19	2,853.82	----	243.96	240.90	1,430.26	16.90	4,357.67	658.45	1,724.02
690.48	308.64	744.50	21.75	465.46	1,041.65	1,351.02	193.00	5,424.74	111.51	307.54
414.77	----	535.71	607.12	1,353.70	493.67	4,252.13	74.00	2,731.30	55.91	2,062.32
2,298.73	48.29	4,276.39	33.20	2,991.77	1,496.59	363.46	1,508.15	4,305.32	11.00	993.20
230.44	2.87	550.59	58.47	944.90	2,718.97	864.33	----	2,090.95	141.00	----
----	----	----	----	44.60	----	164.41	----	----	----	----
516.34	215.06	4,185.40	58.81	626.56	562.64	943.43	45.89	4,250.88	2.09	39.00
144.09	30.75	1,660.15	9.50	25.45	----	418.62	3.00	2,541.23	----	----
1,535.15	----	7,295.23	5.12	.43	248.39	2,391.07	50.05	181.73	----	----
1,469.73	33.00	4,059.73	45.46	1,523.24	1,929.20	1,424.69	1,531.59	2,138.71	2.75	604.21
805.41	34.05	289.24	45.52	3,145.55	787.71	1,246.70	156.00	5,028.98	393.33	15.00
484.60	151.22	1,218.99	4.50	1,888.28	574.32	1,229.93	295.00	5,344.14	6.00	1,637.39
663.10	302.30	1,028.87	102.51	1,673.69	119.20	187.13	232.00	808.63	----	5,956.73
1,276.09	67.25	1,980.00	----	1,295.33	1,798.02	1,886.28	15.00	3,570.87	----	435.05
1,055.38	----	2,074.41	79.08	2,079.33	986.22	2,246.46	230.50	2,411.04	----	796.84
770.80	4.00	3.45	270.07	1,037.52	920.95	1,005.80	70.30	2,040.02	----	2,322.30
1,241.75	----	559.78	68.13	1,350.77	2,624.44	3,604.17	----	2,102.65	988.93	2,356.92
838.18	----	5.75	33.50	222.26	2,498.06	301.03	313.25	7,330.87	----	1,071.35
311.75	13.56	1,608.88	53.78	419.65	1,222.67	1,485.96	325.00	4,568.65	257.12	2,527.29
269.37	3.74	116.40	35.91	353.28	1,408.40	3,229.65	63.70	5,453.99	----	616.12
1,289.21	49.85	12.45	1.00	684.17	174.20	1,376.84	58.00	3,062.97	----	55.00
1,238.17	----	3,007.83	----	2,034.87	162.33	1,357.95	----	2,379.42	14.35	4,652.10
1,291.43	----	345.32	----	518.35	----	1,351.03	104.00	3,951.19	----	----
547.53	----	3,305.00	67.95	516.99	14.20	774.57	2,044.50	3,793.96	3.37	115.35
39,735.99	5,685.14	75,150.02	3,906.19	53,750.50	46,021.04	87,467.72	18,486.10	169,039.35	4,489.78	38,330.53

TABLE 8.—*Disbursements from the United States Treasury to the States and Territories for agricultural experiment stations under the acts of Congress approved March 2, 1887, March 16, 1906, and February 24, 1925*

State or Territory	Hatch Act		Adams Act		Purnell Act	
	1888–1929	1930	1906–1929	1930	1926–1929	1930
Alabama	$628,956.42	$15,000	$326,619.89	$15,000	$140,000.00	$60,000
Arizona	594,803.10	15,000	329,955.61	15,000	140,000.00	60,000
Arkansas	628,139.12	15,000	329,900.00	15,000	140,000.00	60,000
California	630,000.00	15,000	329,926.84	15,000	140,000.00	60,000
Colorado	629,718.82	15,000	328,638.93	15,000	140,000.00	60,000
Connecticut	630,000.00	15,000	330,000.00	15,000	140,000.00	60,000
Dakota Territory	56,250.00					
Delaware	628,382.87	15,000	325,475.12	15,000	139,295.10	60,000
Florida	629,966.04	15,000	329,996.06	15,000	136,523.74	60,000
Georgia	625,593.43	15,000	317,092.87	15,000	140,000.00	60,000
Hawaii		15,000				
Idaho	554,324.13	15,000	325,842.22	15,000	140,000.00	60,000
Illinois	629,564.95	15,000	329,851.62	15,000	140,000.00	60,000
Indiana	629,901.19	15,000	330,000.00	15,000	140,000.00	60,000
Iowa	630,000.00	15,000	330,000.00	15,000	137,965.17	60,000
Kansas	629,995.00	15,000	330,000.00	15,000	140,000.00	60,000
Kentucky	629,996.57	15,000	330,000.00	15,000	140,000.00	60,000
Louisiana	630,000.00	15,000	330,000.00	15,000	140,000.00	60,000
Maine	629,999.62	15,000	330,000.00	15,000	140,000.00	60,000
Maryland	629,967.40	15,000	329,236.48	15,000	140,000.00	60,000
Massachusetts	629,617.70	15,000	330,000.00	15,000	140,000.00	60,000
Michigan	629,676.10	15,000	326,341.20	15,000	140,000.00	60,000
Minnesota	629,917.78	15,000	329,345.00	15,000	140,000.00	60,000
Mississippi	630,000.00	15,000	330,000.00	15,000	140,000.00	60,000
Missouri	625,097.24	15,000	329,999.90	15,000	140,000.00	60,000
Montana	540,000.00	15,000	327,417.04	15,000	140,000.00	60,000
Nebraska	629,932.16	15,000	330,000.00	15,000	140,000.00	60,000
Nevada	629,214.32	15,000	328,180.28	15,000	140,000.00	60,000
New Hampshire	630,000.00	15,000	330,000.00	15,000	140,000.00	60,000
New Jersey	629,949.97	15,000	329,392.06	15,000	140,000.00	60,000
New Mexico	594,509.05	15,000	330,000.00	15,000	140,000.00	60,000
New York	629,757.18	15,000	329,463.01	15,000	140,000.00	60,000
North Carolina	630,000.00	15,000	315,000.00	15,000	140,000.00	60,000
North Dakota	571,502.26	15,000	329,638.85	15,000	140,000.00	60,000
Ohio	630,000.00	15,000	328,514.02	15,000	140,000.00	60,000
Oklahoma	554,002.16	15,000	309,535.19	15,000	140,000.00	60,000
Oregon	615,156.64	15,000	325,000.00	15,000	140,000.00	60,000
Pennsylvania	629,967.43	15,000	329,995.41	15,000	140,000.00	60,000
Rhode Island	630,000.00	15,000	324,520.20	15,000	140,000.00	60,000
South Carolina	629,542.15	15,000	328,460.12	15,000	140,000.00	60,000
South Dakota	573,250.00	15,000	325,000.00	15,000	140,000.00	60,000
Tennessee	630,000.00	15,000	330,000.00	15,000	140,000.00	60,000
Texas	630,000.00	15,000	327,592.26	15,000	140,000.00	60,000
Utah	495,000.00	15,000	329,821.94	15,000	140,000.00	60,000
Vermont	630,000.00	15,000	330,000.00	15,000	140,000.00	60,000
Virginia	627,824.12	15,000	329,949.01	15,000	140,000.00	60,000
Washington	567,102.65	15,000	326,080.11	15,000	140,000.00	60,000
West Virginia	629,968.71	15,000	327,859.12	15,000	140,000.00	60,000
Wisconsin	630,000.00	15,000	330,000.00	15,000	140,000.00	60,000
Wyoming	615,000.00	15,000	330,000.00	15,000	140,000.00	60,000
Total	29,621,546.28	735,000	15,739,640.36	720,000	6,713,784.01	2,880,000

U. S. GOVERNMENT PRINTING OFFICE: 1931

ADDRESS LIST OF STATE AND INSULAR AGRICULTURAL EXPERIMENT STATIONS

ALABAMA.—*Auburn*, M.J. Funchess, Director.
ALASKA.—*Sitka*, H. W. Alberts. Director.
ARIZONA.—*Tucson*, E. D. Ball, Director.
ARKANSAS.—*Fayetteville*, Dan T. Gray, Director.
CALIFORNIA.—*Berkeley*, C. B. Hutchison, Director.
COLORADO.—*Fort Collins*, C. P. Gillette, Director.
CONNECTICUT.—*New Haven*, W. L. Slate, Director; *Storrs*, W. L. Slate, Director.
DELAWARE.—*Newark*, C. A. McCue, Director.
FLORIDA.—*Gainesville*, Wilmon Newell, Director.
GEORGIA.—*Experiment*, H. P. Stuckey, Director.
GUAM.—*Guam*, C. W. Edwards, Director.
HAWAII.—*Honolulu*, J. M. Westgate, Director.
IDAHO.—*Moscow*, E. J. Iddings, Director.
ILLINOIS.—*Urbana*, H. W. Mumford, Director.
INDIANA.—*La Fayette*, J. H Skinner, Director.
IOWA.—*Ames*, C. F. Curtiss, Director.
KANSAS.—*Manhattan*, L. E. Call, Director.
KENTUCKY.—*Lexington*, T. P. Cooper, Director.
LOUISIANA.—*Baton Rouge*, C. T. Dowell, Director.
MAINE.—*Orono*, F. Griffee, Director.
MARYLAND.—*College Park*, H. J. Patterson, Director.
MASSACHUSETTS.—*Amherst*, F. J. Sievers, Director.
MICHIGAN.—*East Lansing*, V. R. Gardner, Director.
MINNESOTA.—*University Farm, St. Paul*, W. C. Coffey, Director.
MISSISSIPPI.—*A. and M. College*, W. R. Perkins, Director.
MISSOURI.—*Columbia*, F. B. Mumford, Director.
MONTANA.—*Bozeman*, F. B. Linfield, Director.
NEBRASKA.—*Lincoln*, W. W. Burr, Director.
NEVADA.—*Reno*, S. B. Doten, Director.
NEW HAMPSHIRE.—*Durham*, J. C. Kendall, Director.
NEW JERSEY.—*New Brunswick*, J. G. Lipman, Director.
NEW MEXICO.—*State College*, Fabian Garcia, Director.
NEW YORK.—*Geneva* (State Station), U. P. Hedrick, Director; *Ithaca* (Cornell Station), A. R. Mann, Director.
NORTH CAROLINA.—*State College Station, Raleigh*, R. Y. Winters, Director.
NORTH DAKOTA.—*State College Station, Fargo*, P. F. Trowbridge, Director.
OHIO.—*Wooster*, C. G. Williams, Director.
OKLAHOMA.—*Stillwater*, C. P. Blackwell, Director.
OREGON.—*Corvallis*, J. T. Jardine, Director.
PENNSYLVANIA.—*State College*, R. L. Watts, Director.
PORTO RICO.—*Mayaguez*, T. B. McClelland, Director.
RHODE ISLAND.—*Kingston*, B. E. Gilbert, Director.
SOUTH CAROLINA.—*Clemson College*, H. W. Barre, Director.
SOUTH DAKOTA.—*Brookings*, J. W. Wilson, Director.
TENNESSEE.—*Knoxville*, C. A. Mooers, Director.
TEXAS.—*College Station*, A. B. Conner, Director.
UTAH.—*Logan*, P. V. Cardon, Director.
VERMONT.—*Burlington*, J. L. Hills, Director.
VIRGINIA.—*Blacksburg*, A. W. Drinkard, jr, Director,
VIRGIN ISLANDS, U. S. A.—*Christiansted, St. Croix*, J. R. Ricks, Director.
WASHINGTON.—*Pullman*, E. C. Johnson, Director.
WEST VIRGINIA.—*Morgantown*, F. D. Fromme, Director.
WISCONSIN.—*Madison*, C. L. Christensen, Director.
WYOMING.—*Laramie*, J. A. Hill, Director.